The Foundry Trade Journal

AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 15. **APRIL, 1913.** **No. 136.**

PUBLISHED THE FIRST WEEK IN EACH MONTH

Subscription Terms: 7s. 6d. per annum, post free.

To place the "JOURNAL" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop at the reduced rate of 5s. per annum, such order to be countersigned by the superintendent or foreman.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

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Contents.

	PAGE
Notes and Comments	205
Association Technique de Fonderie	207
Composition of Cast-iron in Relation to Fracture	208
Pattern Storage in an American Foundry	211
Foundry Sands and their Treatment	212
The Corrosion of Aluminium	215
Blast Furnace Plant and Equipment	216
The Function of the Slag in Electric Steel Refining	218
Some Failures	220
The Microscope in the Foundry	221
Institute of Metals	222
Practical Heat Treatment of Admiralty Gunmetal	223
Air Controller for Melting Furnaces	224
"Drawbacks" in Hand Moulding	225
Points for Young Moulders	226
Commencing a Small Iron Foundry	227
Making and Moulding of the Screw Propeller	231
Oil Fuel in the Foundry	233
An Analysis of Accidents in a Machine Tool Works	234
Charging Different Mixtures in the Cupola	235
Industrial Education	236
The Fairlie Portable Oxy-Acetylene Welding Plant	238
Correspondence	239
Inventions	240
Trade Talk	243
Personal	246
Deaths	246
New Companies	248
Prices of Metal	250
Legal	250

Forthcoming Events.

APRIL 4.

Junior Institution of Engineers.—"Rotary Newspaper Presses," by H. S. Coventry.

APRIL 5.

British Foundrymen's Association (Lancashire Branch).—"Moulding a Horizontal Gas-Engine Cylinder," by J. G. Robinson.

APRIL 12.

British Foundrymen's Association (London Branch).—"The Application of the Microscope in the Foundry," by G. Hailstone.

British Foundrymen's Association (Halifax Branch).—"Moulding Procedure in Loam," by S. G. Smith.

APRIL 26.

British Foundrymen's Association (Birmingham Branch).—"Some further Notes on Moulding Sands," by J. Shaw.

British Foundrymen's Association (Newcastle-on-Tyne Branch).—"What a Patternmaker sees in the Foundry," by W. Matthews

MAY 3.

British Foundrymen's Association (Lancashire Branch).—Election of Officers and Open Discussion on Foundry Problems

NOTES AND COMMENTS.

The Power-Supply Problem.

Of all the problems that beset the engineering fraternity there is none so troublesome as that of power supply. The engineer may devise and develop new plants and engines, he may improve his turbine design, re-organise his reciprocating engine, increase the efficiency of his electric generators and motors, and improve his power distribution system: but inevitably he is brought against the permanent problem expressed in the one word "fuel." So far all the engineer has been able to do is to improve the means of converting the fuel nature has supplied into different forms of energy; he cannot make the power he handles he can only transform it and divert it. Then when, as not infrequently happens, some scientific prophet arises and predicts the near failure of fuel supplies, there is some little inward tremor in the heart of the engineer who looks to the prospects of posterity. Not that posterity, in the words of a famous politician, has ever done much for us; but it is not very soothing to feel that the efforts of generations may soon have to be "scrapped" in the manner suggested. But apart from these somewhat distressing suggestions, it is interesting to consider the possible directions to which power-plant designers of the future may have to turn their attention. While the coal resources of the world are not yet by any means exhausted, we have witnessed sufficient of the effect of their absence or exhaustion in some countries to form a dim idea of what may be the effect on, say, our own country when the present enormous yearly consumption begins to lessen by reason of exhaustion of natural supplies. According to some authorities, that time is within easy comprehension, if not measurable distance, unless fresh resources are discovered. Nor can the oil supplies of the world be regarded with any greater satisfaction; for while there has been much extravagant talk about the future of oil (and its utility is not denied), at present there seems little prospect of that fuel lasting for any great period to fill the place now held by coal.

These points lend considerable piquancy to other suggestions for the harnessing of nature's forces, and there are some countries now of only secondary importance (for example, Norway), whose water powers may raise them to a position of great prominence in the future. But there is also another possibility, recalled by a Paper recently presented before the Royal Colonial Institute, in the course of which the author dealt with the utilisation of the heat of the sun, in tropical regions, for industrial and other purposes. He stated that the Sahara Desert receives an amount of solar heat every day equivalent to that produced by 6,000,000,000 tons of coal. "And," he added, "thoughtful, scientific men say that if some economical method can be found to utilise this lost solar energy (such for instance is the Schuman sun power scheme, which is on its trial at Meadi, near Cairo, and in the development of which Lord Kitchener and the Foreign Office are taking so

much interest) there is no reason why the dreams should not be realised of scientific visionaries, who see great districts of the world—at present arid and useless on account of the sun's intense heat—the locale of the factories, with glass chambers instead of chimneys, and reflectors instead of furnaces, all designed to receive and transmit the daily gift of the sun's heat."

From this one might be inclined to conjure up visions of the tide of industrial activity flowing back from West to East again; though it will doubtless be long before Sahara contains an oriental Birmingham. Nevertheless, there are possibilities at present undreamt of by most men regarding the sources of power for the future, and on this is bound to depend the location of most of the manufacturing industries in which posterity will participate. But before Sahara becomes the centre of industrial activity there will probably be witnessed the utilisation of much material which at the moment is scarcely regarded as fuel. For example, the development of the gas producer has made possible the generation of power from a great variety of material which was previously wasted; and it is indeed difficult to suggest any limit to the possibilities before the internal combustion engine and the gas-producer together.

There is also another possibility which the future will undoubtedly see developed, and that is the utilisation of tidal power. Herein probably lies the solution of Britain's future fuel problem, for a suitable method of harnessing the huge tidal forces which are at the disposal of our sea-girt island would place this country ahead of almost any other in the world in respect of power supply. While it is not a pressing problem at the moment, there is sufficient scope in the question to allow the exercise of abundant ingenuity on the part of our scientific and engineering experts.

The Question of Graphite.

In our last issue we published a Paper on "Specifications for Foundry Pig-iron," presented by Mr. W. B. Parker before the Birmingham Branch of the British Foundrymen's Association. It is not our purpose to criticise that Paper, for the system of specifications appears to be the nearest approach to an acceptable scheme that has yet been discussed. But some of the remarks contributed in the course of the discussion on the Paper call for comment, particularly in the light of the correspondence which appears on another page of this issue.

Attention may first be turned to Professor Turner's remarks, in which he intimated that nobody ever seriously intended that silicon alone should be made the basis of grading. Professor Turner's own work on silicon and its influence on carbon is of sufficient importance to give exceptional weight to his remarks, and we may take it as quite correct that he and many other scientists, while insisting on the importance of silicon, never conceived it possible to grade on the basis of that constituent only. But we submit, nevertheless, that many founders (perhaps not adequately acquainted with the subject) did receive the impression that silicon alone was being advocated as the basis of grading, at any rate within very wide limits of other constituents. This is borne out by various discussions and articles that have appeared in the technical Press during the last few years; and we are confident that the suggestion still has its advocates amongst those who are dissatisfied with fracture grading, but who cannot agree with the claims of those who advocate full analysis.

Professor Turner also refers with some disparagment to the work of Mr. Adamson, and that gentleman's contentions regarding the effect of different forms of graphite. It is quite true that different sizes of graphite were familiar to the scientist long before Mr. Adamson's recent Papers were published, and, on broad lines, definite properties were associated with each description of graphite occurring in iron. But the general conception has been (and we believe still is) that the different forms of graphite are the joint result of the quantities of the other constituents, the temperature of pouring the casting, and the rate of cooling—and to some extent this is correct. From the founder's standpoint, however, this is not the whole story. Given a certain graphite content in a certain condition, the alteration of one or more of the other constituents will produce a corresponding and determinable alteration in the graphite of the remelted and cast iron, and will also affect the amount of combined carbon. But, if Mr. Adamson's contentions be accepted, the same alteration of other constituents may not give the same alterations in the carbon in the case of an iron commencing with a different state of graphite. This would appear to be borne out by the differences experienced between castings from hot-blast and cold-blast irons. The question really resolves itself into whether the different sizes of graphite which are found in cast iron (and which certainly have a direct bearing on the strength of the iron) are only the result of the other constituents, the temperature of pouring the casting, and the rate of cooling, or the result also of the conditions of manufacture. If the latter, and if also, the distinctions between the different forms of graphite are not perfectly broken down in the process of remelting, those different forms of graphite require to be considered as a permanent factor affecting the physical qualities of the iron. It follows then that total carbon and silicon may be a correct basis for the grading of iron manufactured under similar conditions, but as an additional factor in grading must be taken the conditions of manufacture when those differ materially, as they do with cold-blast and hot-blast irons respectively. This is acknowledged by Mr. Parker both in his classification of the iron and in his contention that the temperature of blast should be stated in the specifications; and it is also acknowledged in practice, since one iron will give better results and command higher prices than another, regardless of their respective analyses. If physical properties were governed solely by ultimate chemical analysis, then chemical analysis alone would be a reasonable basis for price and grading alike; and it would only remain to mix in the cupola any combination of iron so as to get the desired composition in order to meet any specific requirement. That this cannot be done will hardly be denied. Within limits, it certainly is being done every day, but the fact remains that the same final chemical composition from one combination of iron does not always give the same results as from another combination. It is, of course, equally true that a mixture made on the basis of the grade numbers of ordinary practice, without regard to the composition of the iron, may be equally misleading; but to the practical man fracture has a significance which is not entirely erroneous, and though that significance applied in conjunction with analysis may probably represent the ideal method, in practice analysis alone is quite as liable to mislead as is fracture alone.

The distinct characteristics accompanying certain fracture appearances require an explanation further than chemical analyses affords, and if Mr. Adamson's contentions regarding not only the sizes of the graphite but the nature of those sizes,

offers an explanation, and if, as appears to be the case, the distinctions between the *natures* of the different forms of graphite are not entirely destroyed in re-melting, we are quite justified in accepting that explanation tentatively and until a better one is forthcoming.

Oil Fuel in the Foundry.

During recent years oil fuel has made considerable headway in this country, particularly in its application to crucible furnaces for foundry and similar work. It has also met with success in the refining of some of the non-ferrous metals; but so far the cupola furnace has been immune from its encroachments. Nor does it appear likely that it will find a field in British cupola practice; but at the same time it is interesting to note a development in this direction noted in American practice. According to Mr. H. Lang, in the "Mining and Scientific Press," San Francisco, Mr. W. Dow, of the Geo. E. Dow, Pumping and Engine Company, Alameda, Cal., has constructed a melting cupola of his own invention, in which oil is the sole fuel. It is said to have proved an unqualified success, melting with regularity the pig-iron for the castings manufactured, and with an economy unapproached by coke-burning apparatus. It is said that he saves fully three-fourths the cost of fuel by the substitution of petroleum for coke, and there is the greatest probability that through further experience the economy will prove still more decided. Not only is the melting done with dispatch, but the bath of metal may be kept fluid and in proper condition for pouring for many hours; in fact, says Mr. Lang, there is no reason why it may not remain molten for weeks, since the jets are so arranged in part as to play on the surface of the metal. By this means it becomes possible to cast at any desired time. It is necessary to supply all the heat of melting by the combustion of the oil alone. The products of combustion must enter the furnace at a very high temperature—perhaps as great as 3,000 deg. F. Mr. Dow has not as yet accumulated the facts necessary for precise statements of results, but since he has put his furnace into regular operation, it taking the place of two coke-burning cupolas, he will be able shortly to speak with authority on a number of phases on which there are at present only theoretical conclusions. Fully realising the desirability of completely burning the fuel before its entrance into the cupola, Mr. Dow has provided his furnace with two heating chambers, one on each side of the shaft at the bottom, in which the atomised oil is brought into intimate mixture with the incoming blast, and from which the hot gases depart through broad apertures over the sole of the cupola. The heat is necessarily very intense, and its effect upon the firebrick of which the structure is composed is very marked. Better fire-resisting materials than the commercial bricks may be necessary for this purpose. Water-jacketing might be resorted to, but for a furnace which is out of commission the greater part of each 24 hours it seems hardly necessary. These developments are probably very interesting from the American standpoint, but there appears little fear of British cupola makers having to reconsider their designs so as to accommodate oil fuel.

American Institute of Metals.

It has been decided to hold the next annual convention in Chicago, from October 13 to 17, 1913, the headquarters being at the Hotel La Salle. A meeting room has been reserved immediately adjacent to the one used by the American Foundrymen's Association.

Association Technique de Fonderie.

The Association Technique de Fonderie, France, is organising a convention and foundry exhibition on the premises of the Ecole Nationale d'Arts et Métiers, of Paris. The convention and exhibition will take place from May 26 to 31 next. The provisional programme of the convention is as follows:—

Monday, May 26.—Registration of the members. The Secretary will be at his office in the Boul. de l'Hôpital, 151, in order to receive the visitors, distribute the medals and printed matters which will have been prepared to facilitate their stay in Paris, and concerning the convention and the exhibition.

Tuesday, May 27 (10 *a.m.*).—Opening of the convention; addresses by the President and the Secretary; discussion of the results of the competition on the Practical Study of Foundry Cupolas; official opening of the exhibition. (2 *p.m. to* 6 *p.m.*) Continuation of the discussion; presentation of various Papers relating to the iron foundry, and discussion of these Papers.

Wednesday, May 28 (10 *a.m.*).—Various papers with regard to the iron foundry, malleable, and steel foundry, and discussion of these papers.

Thursday, May 29 (10 *a.m.*).—Various papers concerning the copper, aluminium, and non-ferrous metal foundry, and discussion of these papers. (2 *p.m. to* 6 *p.m.*) Further Papers on the copper, aluminium and non-ferrous metal foundry; technical papers; discussion of the results of the competition on the Study of the Incidents Occurring in Moulds; Papers on various subjects; and discussions of these Papers. (8 *p.m.*) Banquet at the Palais d'Orsay.

Friday, May 30, *and Saturday, May* 31 (10 *a.m. to* 6 *p.m.*).—Visits to works, and individual visits to the Exhibition.

Sunday, June 1 (10 *a.m. to* 6 *p.m.*).—Exhibition in view of visits of students, foremen, workmen, etc.

Visits to foundries will be arranged on Friday, the 30th, and on Saturday, the 31st. A special programme will be drawn up on this subject and sent on application.

The admission to the Convention Halls will be strictly reserved to the members of the Association Technique de Fonderie, and their guests wearing their medals.

The admission to the Exhibition will be permitted to bearers of free tickets distributed by the Secretary of the Convention. Members of the Association Technique de Fonderie, and persons wishing to receive tickets in advance, are requested to kindly inform the Secretary, and to mention the quantity. They are requested to be good enough to give him the names and addresses of the partakers for publishing purposes. Moreover, any respectable person, who desires to visit the Exhibition, will receive a ticket at the Secretary's office at the entrance, on stating name and occupation.

The Papers so far entered include:—"New Testing Methods in the Copper Foundry," by Messrs. Guillet and Portevin; "De-oxidising Agents in the Copper Foundry, and their Use," by Mr. Portevin; "Thermal Treatments in the Foundry and their Use," by Mr. Guillet; "American Foundries and Factories," and "Oil Heating of Metallurgical Furnaces," by Mr. Brasseur; "Numerical Classification of Castings, its Deficiency; Chemical Classification," by Mr. Gueneau; "Cast-Iron in the Light of Recent Researches," by Mr. Hatfield; and "Recent Researches on Zinc and Aluminium Alloys," by Dr. Rosenhain.

Composition of Cast Iron in Relation to Fracture.

At a meeting of the Lancashire Branch of the British Foundrymen's Association, held on Saturday, March 1, Mr. F. R. Penlington presiding, a Paper was read by Mr. Sidney G. Smith, of Bradford, on "The Composition of Cast Iron in Relation to Fracture." The Paper was as follows:—

Although cast iron has for many years been used for engineering purposes, it is surprising what a small amount of definite and reliable knowledge has been gained regarding its true properties. The chemist can give the analysis and percentage of the contents of any class of iron, and can possibly give the influence of one element upon the other, and may be able to state almost definitely the condition of the iron under certain circumstances in terms that are intelligible to the student. But analysis is by no means everything in a foundry.

Recent discoveries, accidental and otherwise, prove that there are numerous conditions to consider quite apart from the analytical contents. Two irons showing exactly the same composition will sometimes produce castings having totally different physical qualities, and one may be 50 per cent. stronger than the other.

It is the complexity and variable conditions of the compound known as cast iron that make it difficult to always obtain uniform results. Obviously with the advent of the foundry chemist there will arise a tendency to abolish, or disregard, the usual numbers, and procure iron by analysis alone. I quite agree that foundry iron should be purchased and mixed by analysis within reasonable limits, but also contend that numbers should approximately represent specified analyses. Grade numbers should vary with fracture. But it is urged that fracture is not reliable, and often it occurs that a No. 2 can be taken for a No. 3, a No. 3 for a No. 4, and so on; also that the contents vary largely in the same numbers. These statements, however, do not refute the claim that grade numbers should represent an approximate analytical content. I have always associated grade numbers with analysis, fracture, tensile, transverse, hardness and pressure tests, with due consideration to thickness, cooling, and design of castings.

The following table gives the symbols, atomic weight, and specific gravities of the constituents of cast iron. The constituents mentioned, of course, exist in the iron as compounds and not as elements.

TABLE I.

	Symbol.	Atomic weight.	Specific gravity.
Phosphorus	P	31.00	1.8
Sulphur	S	32.00	1.97
Carbon (graphite) ..	C	12.00	2.20
Silicon	Si.	28.10	2.49
Iron	Fe	56.00	7.86
Manganese	Mn.	55.00	8.00
White pig-iron	—	—	7.55
Grey pig-iron	—	—	6.85

Grey iron melts at about 1250 C. (2282 F.).
White iron melts at about 1150 C. (2102 F.).

Phosphorus exists as phosphide of iron, Fe_3P. It is reduced in the blast furnace, and, separating from its associates, combines with the iron. Its chief virtue in cast iron is that it imparts fluidity.

Sulphur exists as sulphide of iron and manganese, FeMnS. Sulphur having a strong affinity for both metals, like phosphorus, it separates from the sulphates, iron pyrites, and also the fuel in the furnace and unites with the iron at low temperatures. Its presence has a strong tendency to harden the iron, being influential in combining the carbon.

Carbon exists in three forms, diamond, graphite and charcoal. It occurs in grey cast iron as graphite, and in white iron it is chiefly in combination with the iron, as a carbide. There are several forms of carbon known and unknown, but only the latter two are identified by chemical analysis: the other modes have been discovered by micrography. The presence of carbon makes it possible for the iron to melt, retain its heat, and run fluid. In the graphite form it softens, and in the combined form it hardens the iron.

Silicon occurs as silicide of iron and manganese; it is reduced from silica in the blast furnace at a very high temperature. Its influence upon the iron up to 3 per cent. is to soften, by reason of its tendency to increase the graphitic carbon. Above 3 per cent. the iron becomes rather harder.

Manganese is hard and brittle, and seldom reaches in ordinary cast iron 2 per cent. It exerts a distinct tendency towards combining the carbon, thereby hardening the iron to some extent; but where sulphur is high manganese neutralises its hardening effect by combining with it, forming manganous-sulphide, which passes off as a slag.

The analysis and physical properties of different brands and grade numbers of iron will vary according to the district where the iron is made, due to the mixture of different ores, ironstone, etc., of which the burden is composed. Hence, for the purpose in view, I will strike an average analysis of each number of ordinary British irons and make them typical. Hematites and special irons are not included. Table II. shows the composition of each grade number in the form of a 12-in. cube.

TABLE II.

	No. 1*. Per cent.	No. 2†. Per cent.	No. 3‡. Per cent.	No. 4§. Per cent.	Mottled‖. Per cent.	White*. Per. cent.
Combined carbon	0.15	0.20	0.25	0.35	1.50	3.00
Graphitic carbon.	3.30	3.15	3.00	2.80	1.50	nil
Silicon	3.00	2.75	2.50	2.00	1.00	0.70
Manganese ..	1.00	0.75	0.65	0.60	0.50	0.30
Phosphorus ..	1.50	1.50	1.50	0.50	1.50	1.50
Sulphur	0.02	0.03	0.04	0.05	0.08	0.10

* Extremely soft and open grained.
† Very soft and open grained.
‡ Soft and medium open grained.
§ Close grained and medium soft.
‖ Very hard and close grained.
**Extremely hard and granular.*

The fracture and composition of No. 1 grade, as shown in Table II., conveys to the mind at once a metal that is dead soft, and with no other number added, it would be of very little service in the foundry. As the analysis shows, the silicon content is high and the carbon may sometimes reach the saturation point; it would border on, or be a kishy iron, due to the high silicon precipitating a still higher carbon into graphitic flakes. In normal cooling these large flakes can be seen throughout the matrix or fracture, and often during the falling in temperature of such an iron (which, as a rule, is of a dazzling whiteness when tapped from the furnace), these graphite flakes can be seen rising from the iron into the air, which indicates that the iron during cooling throws off the carbon it cannot contain at the lower temperatures. Such an iron would give very unsatisfactory transverse, tensile,

crushing or deflection tests, and under pressure in a thick casting it would sweat as though full of open pores, which would be due to the large facet flakes of graphite entirely breaking up the continuity of the matrix. Also, although it is an iron that gives the least contraction, it has a greater liquid shrinkage, and is of low specific gravity. It will probably have a higher melting point and retain its heat longest of any other grade.

The analysis of No. 2 grade iron conveys to the mind a very soft open-grained iron. It is useful for very thin ornamental and thin-section castings, such as connections for heating apparatus, grate work, etc., but is of little service where stress of any kind is required. It will contract more than a No. 1 and its liquid shrinkage will be less, its matrix a little closer, and its melting point lower. Is very soft to the tool when machined, but does not give a smooth, even surface, and is of little service for hard wear.

No. 3 grade iron is serviceable for castings of pulleys and pipes, etc. It is closer in grain, will endure frictional and surface wear longer, will have less liquid shrinkage, a slight increase in contraction, and will give more satisfactory tests than a No. 2 iron.

No. 4 grade iron is the most serviceable iron for general foundry use. It is closer-grained, the graphitic carbon is in a more finely divided state than in the lower numbers, and it will have the best liquid shrinkage of any of the numbers, above or below. It machines well and gives a smooth, clean surface, will stand shock, wear and tear, and give satisfactory tensile and transverse tests, with good deflection. It is suitable for many engine and machine parts, gearing, columns, stanchions, etc.

In No. 5 grade iron we are nearing an iron that is strong and bordering on hardness. It is suitable for very thick castings, and with slow cooling would machine clean and close, but would be of little use for small or thin castings. It will give good tests. The contraction now increases as the numbers rise, and the point is passed where the liquid shrinkage is least.

Mottled iron is a close No. 5 and white iron. It is a very unsatisfactory iron and difficult to manipulate, chiefly owing to the white iron being in patches, and alone. Its use is very limited for any kind of castings, owing to its hardness and brittleness.

White iron is extremely hard and brittle and will not machine. The contraction and liquid shrinkage is considerably more than in grey irons. The mottled and white grades are of some service for weights, wire guides and guides in small merchant mills, pile shoes, etc.

For many kinds of work the above irons referred to may be judiciously mixed together, or mixed with special irons, such as cold-blast and Swedish irons, hematite, siliceous or glazed iron, manganiferous iron, or even spiegeleisen, by remelting. The writer is aware that the wisdom of this is very much questioned, the contention being that iron of a widely different composition will not mix. But practice has in numerous cases proved otherwise, though it is admitted that proper manipulation in mixing is important.

It will be noticed in each of the irons quoted the metalloids are under 10 per cent., thus leaving iron by difference over 90 per cent. It is chiefly due to the variations of the metaloids and manganese that different grades of iron are produced. These variations depend upon the amount and composition of the iron ore or iron-stone, fuel and fluxes comprising the burden, and also on the temperature, blast pressure, and general working of the furnace, and other matters known and unknown to iron-makers. With normal cooling, the proportions of the metaloids have considerable influence upon the temperature of the iron. For instance, a No. 1 iron containing a high percentage of silicon and carbon, will retain its heat much longer than the higher numbers, both in the liquid and solidified state. A No. 4 will solidify quicker, and white iron quicker still. It may be urged that the lower numbers are capable of a higher temperature, and that that would account for the slower cooling. Such a contention does not always follow. For instance, if a No. 1, a No. 4, and a white iron of the same brand, each containing nearly the same amount of phosphorus, were melted to the same temperature and cast in 12-in. cubes, the white iron would solidify first, the No. 4 next, and the No. 1 last.

As another instance may be taken a No. 1, a white iron, and a special iron containing a very low percentage of impurities (such as Swedish iron), each being melted to a dazzling whiteness; in this case the special iron would need more fuel than the No. 1 and the white irons. If, say, 5 cwts. of each were poured into a long level open-sand runner, it is questionable which would run farthest; but if each of these metals were cast into a 12-in. cube mould, the No 1 would retain its heat very much longer than the white or the special iron. I mention this matter because of being asked on more than one occasion whether silicon promotes fluidity; and I presume in practice there is some doubt about it. A high percentage of silicon will both promote and prolong fluidity if well covered in the ladle.

Without undue repetition, to summarise the points referred to, the relation between composition and fracture under normal conditions is as follows:—A high carbon and silicon will show in the pig a large open fracture. In the absence of a high silicon, a very high carbon will exhibit a similar open fracture. Neither silicon nor carbon are softeners in themselves. It is the influence of silicon upon the carbon in precipitating large graphite flakes which break the continuity of the matrix, which imparts softness. When silicon exceeds 3½ or 4 per cent., as it sometimes does, its influence is, irrespective of the carbon content, to produce a more close and fine fracture and to slightly harden the iron. With such a siliceous iron judgment by fracture is uncertain, but when closely examined the fracture will be smooth or glassy, devoid of tenacity, hence a short "potty" break, which term implies that it breaks like crockery-ware.

As the grade numbers rise from one upwards, so do the free graphite flakes become less in size, the percentage of free graphite and silicon diminishes, and hardness increases. In a No. 4 the metalloids seem more uniformly combined, or mixed chemically or mechanically.

A No. 5 exhibits a closely knit granular fracture, and upon close observation often discloses to the naked eye, a fine net-like formation of a lighter colour than the mass intertwined throughout. The surface appearance of the fracture is rough and irregular, which is an indication of a strong iron.

The fracture of a mottled iron cannot be misunderstood, patches, streaks and spots of white iron are plainly visible embedded in the mass of grey iron. The surface of the fracture is smooth, although a little irregular. A white-iron fracture shows a fine-grained, smooth, uniformly regular surface, and is the colour of its name. It entirely lacks tenacity or cleavage, breaking into pieces with slight blows. Practically the whole of the carbon is in combination with the iron.

In conclusion, a few general remarks in reference to contraction may be made. According to some text-books, grey iron contracts one-eighth of an inch to the foot. But if grey iron contracts uniformly one-

eighth of an inch per foot, how is it that castings of any great length made from the same pattern by the same moulder with the same core will vary in length? Grey-iron contraction will vary considerably, not only in relation to composition and condition, but in relation to thickness. There is a wide range of grey irons from a soft open-grained to a fairly hard close-grained iron; these irons differ chiefly in silicon and carbon contents, the former being high and the latter low. A soft high-silicon high-carbon iron will contract the least, and a low-silicon high-combined-carbon iron will contract most.

Apart from the composition of the iron, variation will occur in thin and thick sections, contraction increasing as the thickness decreases and *vice versa*. A 12-in. cube, if cast and fed solid, will not contract to the extent of a 12-in. square plate 1 in. thick. The same law applies to circular thickness, but with other designs of castings wherein ribs and brackets are displayed they become factors that must be taken into account, because such often give rise to a further variation. So it will be obvious that in a general foundry, in order to work to accurate sizes allowances must be made.

Why an open-grained soft iron should not contract as much as a close-grained dense iron, is not so problematical as why a thin section should contract more than a thick section, when the iron is the same quality, unless it is dependent upon the state the carbon assumes when cooling; probably the same law is operating and obeyed in both cases. In the former the low and high specific gravity largely accounts for the difference. Regarding the latter, this is due to the percentage of combined carbon, which is controlled by the rate of cooling.

Supplementing the Paper, Mr. Smith stated that he often used the thumb test in going over a fracture of iron. To draw the thumb over a piece of white iron was like going over a bit of glass; grey iron was rougher, but still the thumb went over it fairly smoothly; where the fracture was small and the graphite flakes very finely divided it was rougher still, it bit the thumb or finger. The touch for this test was more or less acquired. After some little time one was able to judge an iron fairly well by the feel of it. Contrasting two specimens, he pointed out that the thumb went fairly easily over the one which seemed rough; the other looked smooth, but bit the skin of the thumb.

Discussion.

Mr. W. H. Sherburn said that, while making every allowance for the uses of chemical analysis, he had always held—and he believed Mr. Smith was in agreement with him—that it was not everything, and a man who judged by analysis alone would be left far behind by one who, though ignorant of chemical analysis, knew a good deal about the touch and the fracture and one or two other practical things. Mr. Smith, however, indicated the ideal position, viz., chemical analysis combined with a knowledge of fracture and of touch. There were one or two points he wished to raise. In the first place, why did iron which was malleable when first put into the crucible, turn to a crystalline form? No doubt all of them had seen pieces of hard iron which at one time were perfectly malleable. Also, he had been under the impression that the No. 1 grade of iron melted most easily, but he understood Mr. Smith to say it was the most difficult. Was that a fact? He had been able to melt it in a crucible, and he was not sure that he could melt any of the other grades so easily.

Mr. Hogg asked whether Mr. Smith could advise them how to prevent "draws" behind the flanges in casting pipes. The makers of cast-iron pipes had frequently a great deal of trouble in connection with tests; it often happened that of two bars made of the same composition and under the same conditions one would stand the test and the other would not. Could Mr. Smith explain that and state whether No. 4 or some other iron was most suitable for pipes? Also, could he advise how to deal with iron containing 1.5 of phosphorus?

Mr. Nicholls remarked that he did not clearly understand the distinction between liquid shrinkage and contraction. Would Mr. Smith explain it?

Mr. A. Key referred to the statement that No. 4 gave the best results for general foundry uses, and was suitable for many engine and machine parts. Did Mr. Smith mean that the iron, when made, must be of that analysis, or that a mixture of that composition should be used along with a proportion of scrap? He was anxious to have that point made clear. Mr. Smith also said they might get two irons of similar chemical constitution, but widely divergent in physical properties. Was it simply that No. 4 was a good iron, or the best iron to use, or that they were to regard that analysis as the best to work to?

Mr. Harrison pointed out that the Paper contained a statement that manganese exerted a distinct tendency towards inducing combined carbon. One would expect from that that an iron high in manganese would be high in combined carbon and *vice versa*, but in the six groups of analyses those which were highest in manganese had the lowest combined carbon. No. 6, which had the lowest percentage of manganese, had the highest combined carbon.

Mr. Simkiss said that the analyses of iron were of considerable assistance, but through furnace or cupola conditions they could be greatly modified. Why was it that the chemist mixed his materials and charged his cupola to get a certain grade of metal, and yet did not know what he would get till the product had been broken and examined in fracture? On the point of testing he could cite an interesting case. Two bars were cast on a crane barrel, side by side, and of the same material, and practically the same size. One bar stood a test of 4,300 lbs., the other failed at 3,260 lbs., the deflection being about 0.4. Those sort of things were distressing to the practical man.

Mr. Andrews asked whether, if two bars were cast of the same brand of metal, approximately at the same temperature, the bars to be machined, there would be any great difference in the results? Also, with regard to pressure tests, was there any method of testing, other than of testing the actual casting, which would give a satisfactory resul?

Mr. Smith, in reply, said that Mr. Sherburn had set him a poser with the query "Why does the malleable, fibrous nature of cast iron return to a crystalline form?" He had asked probably a dozen metallurgists the same question, and never been able to get a satisfactory answer. He had been asked to define the difference between liquid shrinkage and contraction. The former was the shrinkage of the casting before it was solidified, regardless of the time occupied; it was the shrinkage while the metal was in a molten condition. After it solidified contraction took place. Referring to the tables showing the composition of six varieties of iron, a certain amount of liquid shrinkage was got in No. 1; in No. 2 it was a little less; in No. 3 it was again less; and the diminution continued in No. 4, where it was the least of all. In No. 5 the shrinkage increased, and in No. 6 it was greater still, but in these cases it was not accompanied by spongy, porous nature and the latter perfectly solid.

MR. W. H. SHERBURN: Have you ever found two or three grades in one pig?

MR. SMITH replied that he had many a time. He was referring to a piece of grey iron. He did not know where it was made, but, although a small piece, it showed two distinct grades. Continuing, MR. SMITH said the best way to prevent "draws" behind flanges was to cast the pipes vertically. Mr. Hogg also wanted to know whether iron containing 1.5 of phosphorus was all right? Well, if other things were in order, he had found no great difficulties from an iron containing that percentage as far as pipes were concerned. Hundreds of thousands of tons of pipes were cast with such iron. In the case of "draws" occurring, a chill might be put on; that might not make it solid right through, but it would go a little way. Mr. Key had inquired whether No. 4 was the best, and why? No. 4 was not necessarily always the best, but for small machine parts it was preferable. The carbon was in a more finely divided state than in the other cases, and he should prefer a machine casting from No. 4. Of course, there was not a great difference between that and No 3; the latter would carry more scrap of medium or small size. Mr. Harrison had asked a question which he was probably able to answer himself. Mr. Harrison would agree that if manganese were added to any of the grades shown it would increase the carbon. As he said in the Paper, the effect of manganese was, to some extent, to counteract sulphur, which passed off in the slag; and they would notice that in the tables where the percentage of manganese was high the sulphur was low. By adding manganese one grade might be changed into another. He would not put pure manganese into the cupola; spiegeleisen containing 14 per cent. of manganese might be used.

The point raised by Mr. Andrews as to why one bar did not bear the same stress as another bar out of the same ladle frequently cropped up. He had seen a difference of 3 or 4 cwt., although the conditions, as far as one could see, were practically identical in both cases. He could not explain it, and he did not know that anybody else could. He knew of no pressure test except the one put on the actual castings.

MR. ANDREWS remarked that when he spoke about test bars he was thinking of Mr. Cook's experiments, two irons of similar analyses giving different results all round—one very much lower than the other. He did not mean that the two bars came out of the same ladle, but that the two mixtures were made up to the same analyses and melted at approximately the same temperature.

MR. SMITH said he should attribute the varying results obtained by Mr. Cook to the state of the carbon.

MR. KENYON moved a vote of thanks, which was seconded by Mr. H. Sherburn, and heartily carried.

HART-PARR CO.

Form No. D 2 Date.....

PATTERN RECORD.

Name ..... Part No. .....
Supercedes No. ..... Name .....
Superceded By No. ..... Name .....
Pattern is for ..... Casting
To be used for .....
Pattern is to be made of ..... Except .....
Allow for ..... Shrinkage
This pattern order is for { New Pattern / Change in old pattern number .....
Further Remarks .....
Ordered By ..... Date .....
To be made in ..... Dept. to be finished by .....

PATTERN SHOP REPORT.

Record must be made below of each loose piece to Pattern and each loose piece must have part number and letter number
The following pieces for Pattern No ..... were made and delivered to ..... Foundry
By ..... Date .....
Loose Piece No. ..... Letter No ..... Name ..... Made of .....
Loose Piece No. ..... Letter No ..... Name ..... Made of .....
Loose Piece No. ..... Letter No ..... Name ..... Made of .....
Pattern Checked by ..... Date .....
Above Pattern and Parts were Received
By ..... Foundry. By ..... Date .....
Same are stored as follows:
Pattern No. ..... Section No. ..... Rack No. ..... Shelf No. .....
Pieces No. .....
Are stored in Section ..... Rack No. ..... Shelf No. .....
Core Box No. ..... Stored in Sec. Rack No. ..... Shelf No. .....
Follow Board No. ..... Stored in Stall No. .....
Flask No. Z ..... { Drag No. Z ..... Letter No. ..... / Core No. Z ..... Letter No. ..... / Check No. Z ..... Letter No. ..... / Check No. Z ..... Letter No. ..... } In Stall No. .....
Match Board No. Z .....
Match Board No. Z .....
Record was made in ..... Foundry Record Book By ..... Date .....
Record was made in Drafting Room Books By ..... Date .....
Further Remarks .....

PATTERN RECORD BLANK USED BY THE HART-PARR COMPANY.

Pattern Storage in an American Foundry.

In an article in the "Iron Trade Review," describing the works of the Hart-Parr Company, Charles City, Ia., U.S.A., some particulars are given of the pattern-storage system adopted by that Company, whose works include foundries, machine shops, erecting shops and numerous other departments.

The pattern-storage room is absolutely fireproof, the construction of the walls and roof being entirely steel and concrete. The shelves consist of 2-in. reinforced concrete slabs supported by a framing of steel angle bars. The shelves are numbered and the customary provisions are made so that any pattern which may be required can be located without trouble. The foundry keeps an elaborate record of every individual pattern, in the form indicated in the accompanying illustration. This form is made up in sheets, $8\frac{1}{2} \times 13$ in., arranged for insertion in a loose-leaf book. The record includes the name of the pattern together with the various identification numbers and a complete schedule of the loose pieces. This record also indicates the number and location of the core boxes used in connection with the pattern and, in addition, such follow boards and flasks as may be specially required for use with this particular pattern. The record is signed by the entry clerk so that the responsibility for its correctness may be determined.

Foundry Sands and Their Treatment.

By Algernon Lewin Curtis, M.E.

(*Continued from page* 107.)

The Relative Value of "Tests" as Applied to Moulding Materials.

At the inception of these articles it was not the author's intention to enter any field other than that regarding the mechanical treatment of sands. As, however, more or less conflicting theories have been propagated on the subject since the advent of the moulding machine, it becomes necessary to ascertain their respective values. Before proceeding it may be pointed out that any remarks made here must not be taken as personal criticisms.

Fig. 1. Fig. 2.

In taking up this subject, with its more or less important ramifications, no little disappointment has been experienced through the lack of scientific procedure existing in many of the large iron and steel foundries to-day; the executive of some, keeping what they

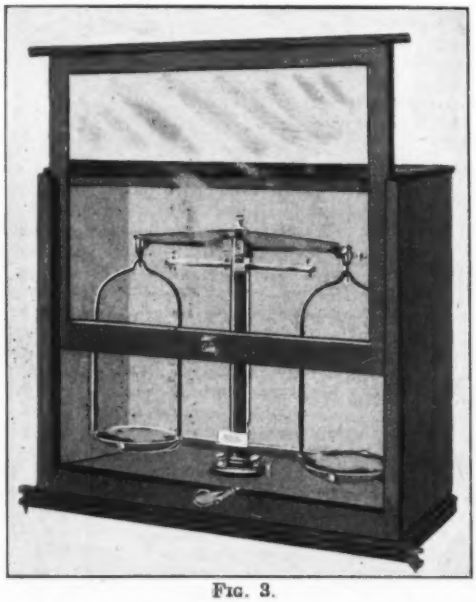


Fig. 3.

imagine secrets, in a small note book, and failing at times to understand their own products. In one case where the writer treated a sample of old sand with clay, he was afterwards only abused for his pains, it being insinuated that a new sand had been substituted. In another case the writer was able to point out to an important steel works the waste that was taking place, and show how a simple remedy would affect considerable ecenomy; rigid conservatism and lack of knowledge of the material used was costing that, and possibly other firms, large sums annually.

When examining the large amount of literature professing to deal with the subject of moulding materials, one is struck by the great want of practical application contained; for, with the exception of one or two instances, little practical data is available regarding the results of such theories; also, many tests and methods of examination given are only applicable to new sands, which affects their respective value considerably, if used on sand mixtures containing old sand, coal and coke dust, clay, or additional organic and other matters.

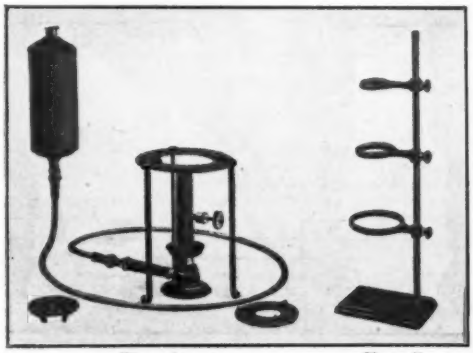


Fig. 4. Fig. 5.

In analysing the value of tests for moulding materials prior to the use of the materials in practice, several things must be borne in mind:—

(*a*) The accuracy of the proportioning of old and new sands, coal and coke dust, clay, compounds, organic matter, and water.

(*b*) The uniformity with which such materials are mixed.

(*c*) The pressure at which such materials are rammed or compressed in a core or mould.

From this it will readily be understood that, however accurate a chemist may be in a laboratory, his efforts become useless unless the proportions of materials prescribed are observed in the foundry itself, which, under ordinary methods, by ordinary men, is almost impossible, though it may be achieved in a machine specially designed for the purpose. Moreover, however elaborately a chemist may mix his material in a specially-constructed mill, if they are afterwards indifferently incorporated in practice, what is the use of a chemist, or his tests? Lastly, experiments can be carried out in the laboratory by constructing miniature moulds or cores, in which the

pressure or densities are recorded to three places of decimals; such labour, however, is futile unless the sand in practice is properly treated to conform to such pressures and means are provided for seeing moulders ram their moulds at such predetermined pressures. It might be argued that the latter course is not only too difficult to follow, but also of little or no value. Perhaps moulding-machine manufacturers are the best judges, as one of their important functions is the determination of suitable pressures with which to mechanically ram or compress sand mixtures in moulds.

When referring to tests of moulding sands, one writer states that "It may be granted at once that, in most cases, a fair amount of latitude in most of the properties of a given sand may be allowed, without making it totally useless for a particular casting."

FIG. 6. FIG. 7.

From this remark it might be assumed that so long as castings can be made to hold together, it does not matter whether they are "cut," "scored," or "blown," on account of the great latitude allowed in the properties of a sand mixture. It can be stated, however, and most founders will agree, that their trouble is not in having a sand which is useless for making castings with, but rather the fact that they cannot keep on duplicating a mixture found by experience to be suitable, owing to the ingredients being incorrectly proportioned or inefficiently mixed or treated; for though the sand may seem correct in its external appearance, it may still keep "cutting" and causing blow holes. This is because too much latitude is allowed when preparing the mixture. What is the use of expensive laboratories and a chemist working to 0.1

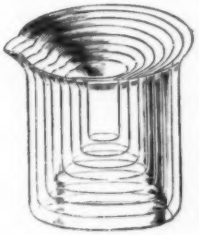


FIG. 8.

FIG. 9.

of a milligramme, if in practice the materials are not proportioned or mixed to within 20 per cent. of the prescribed formula? No latitude should be allowed in the preparation of a sand mixture, if it is necessary to repeatedly duplicate its composition; and a sand which has varying physical qualities ought to be discarded in favour of one whose constituents have a minimum of variation. So long as sands are mixed without artificial preparation, then great differences must be expected, with resulting bad castings, especially in steel foundries.

Some writers have stated that by the aid of chemistry sand mixtures can be controlled and altered day by day and week by week in the foundry. This is a fallacy, because accurate ultimate analysis would take so long that the cycle of change in a moulding sand would be complete before the original sample had been entirely analysed.

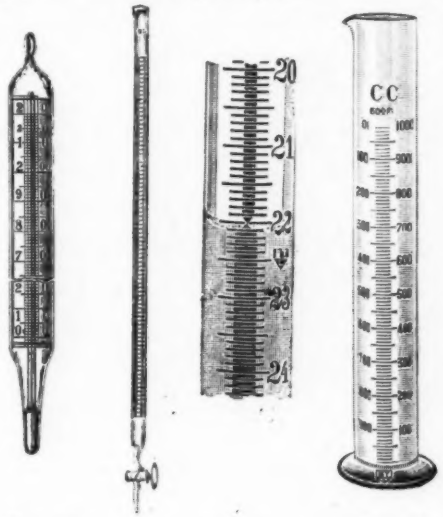


FIG. 10. FIG. 11. FIG. 12.

When there is a proper understanding between the heads of the foundry and the laboratory, the use of chemistry will be of much greater value; but in many cases chemistry is chiefly applied in the requisitioning of raw materials, or as a means of detecting trouble. If chemists could sometimes see their beautiful recipes and formulæ ruined by an excess of one or another substance in practice, they would complain more than at present.

The actual application of chemistry in regard to moulding sands to-day is better understood when it

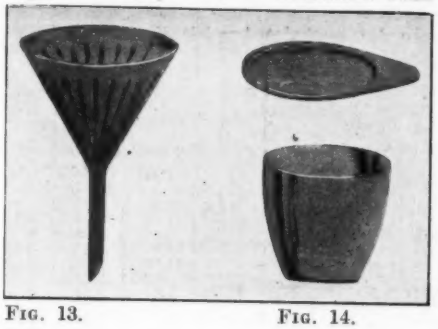


FIG. 13. FIG. 14.

is stated that many of the moulding-sand and clay merchants cannot furnish even a rational, let alone an ultimate, analysis of their products. Every sand, both new and old, sand mixtures, coal and coke dust, clay, compounds, and even water, should be analysed periodically, the latter especially, because of the salts and other substances sometimes contained which may seriously affect the binding properties of a sand mixture.

In a previous article of this series details of a reasonable method of analysis for sands were given. It was not then though necessary to give particu-

lars of the apparatus with which to conduct the analysis, but since the article in question appeared, the writer has been asked to furnish a simple and inexpensive list of articles for the purpose of conducting such experiments. The apparatus can be obtained from such well-known firms as Messrs. Baird & Tatlock (London), Limited, 14, Cross Street, Hatton Garden, London, E.C., from whose catalogue readers will be able to select the amount and quality of their own requirements, other than those pieces enumerated here. This information is not given as indicating with what chemists should or should not equip their laboratories; it is rather intended for founders not possessing the advantages of a laboratory, and those perhaps working as moulders who wish to advance in their profession, so that by the judicious investment of a few pounds, certain chemical experiments can be performed. It must be understood, however, that chemical analysis cannot be learnt by simply conducting a few experiments; though, by attending the excellent technical classes and studying the subject as much as possible, a useful working knowledge can soon be obtained.

Before sand can be analysed it should be gently ground in order to mechanically break up the cementation of its particles. This is done in an ordinary pestle and mortar (see Fig. 1). It is then sieved through a sieve of 100 mesh (Fig. 2), and after which it must be weighed; for this purpose a balance should be provided. The difference in balances is so great that readers must select one to suit their own tastes and pockets. It will suffice to state that the balance shown in Fig. 3, sensitive to 0.1 of a milligramme, fitted in mahogany case, with sliding front, having a capacity of 100 grammes, is sufficiently accurate for a beginner. As weights are not generally supplied with the balances, a set of the former is necessary; those from 100 grammes to 0.1 of a milligramme, packed in a mahogany case with glass covers and forceps, being generally used.

Means should also be provided for drying a sample of sand for a definite time at a fixed temperature. This can be done by either a gas burner, or where gas is not available, by a spirit or oil lamp, the two latter having regulating mechanism. Gas is, however, preferred, using a Bunsen burner. Where gas is not obtainable, a useful lamp is the automatic Bunsen burner for methylated spirit illustrated in Fig. 4. Whichever means of heating is employed necessitates a retort stand, with several rings, as shown in Fig. 5, and a sand bath (Fig. 6) placed on a convenient ring under the lamps. A filter stand is also necessary, the double one being preferred (Fig. 9), also a number of different sized glass beakers (Fig. 8).

Having weighed the sand, placing same in a suitable beaker on the sand bath over the flame, it is necessary to adjust the heat by a thermometer, the instrument shown in Fig. 10, which records up to 360 degs. Cent., being quite suitable. For accurately measuring liquids, usually done in cubic centimetres, a standard or Mohr burette is best, having a capacity of 50 c.c. and stop-cock, as shown in Fig. 11. Watch glasses (Fig. 7) for covering the beakers, and glass stirring rods will also be necessary. Besides a burette, a graduated glass cylinder of 250 c.c. will be found useful (see Fig. 12). Funnels for filtering (Fig. 13) are also required, and also filter papers, No. 589 Blue Ribbon being preferred. The last, and probably the most expensive piece of necessary apparatus, if a large size is required, is a platinum crucible (Fig. 14), for fusing quartz with Na_2CO_3. A crucible of 10 c.c. capacity, however, is quite large enough at first, measuring 2.7 c.m. high by 2.6 c.m. in diameter, and weighing about 0.3 ounces troy, and costing about 120s. per ounce.

For conducting experiments on sands with the apparatus enumerated, several chemicals will be required, the chief of which are:—Sulphuric acid (H_2SO_4); sodium hydroxide (NaOH); hydrochloric acid (HCL); sodium carbonate (Na_2CO_3); ammonium hydroxide (NH_4OH); and bromin. Such chemicals can be obtained in 250 c.c. glass-stoppered bottles, with blown labels, thus being ready for use at any time—except the bromin, an ounce of which will be ample at first. Great care should be exercised when using this latter element, and those unaccustomed to its subtle properties had better receive instructions before trying experiments with it, as not only is it a very poisonous and volatile liquid, but its fumes are very harmful to the eyes. Space prohibits giving full details here of the *modus operandi* for conducting an extensive analysis of moulding sands; though a study of the rational method previously mentioned, and reference to standard works on the subject, will assist readers anxious to attempt the work.

Many founders from time to time require the analysis of leading English moulding sands. It was hoped that an extensive list might be provided, but as many good deposits exist, the owners of which furnish no analysis, any list will be necessarily small. The author, however, will be pleased to receive from any source samples and analyses of moulding sands and clays, which, if possible, will form the subject of a further chapter. The following are a representative few:—

Analyses of Sands.

Name.	Silica.	Alumnia.	Ferric Oxide.	Lime.	Magnesia.	Water.	CO_2 and Organic matter.	Matter soluble in water.	Loss on Ignition.	Authority.
Mansfield	89.20	—	2.09	0.11	Tr.	6.96	1.29	0.10	—	Mansfield Sand Co
Mansfield	83.40	3.14	7.47	0.20	0.60	—	—	—	—	McWilliam & Longmuir
Warsop (Mansfield) ..										
Warsop (Strong)	78.70	7.57	2.23	2.70	1.73	—	—	—	5.05	Smith.
Warsop (Medium)	84.90	5.56	2.34	0.40	1.24	—	—	—	1.84	Smith.
Warsop (Weak)	85.30	6.03	2.57	0.80	0.46	—	—	—	1.62	Smith.
Kidderminster (Red) ..	83.69	4.10	6.26	0.66	0.51	—	—	—	—	McWilliam & Longmuir.
Yellow (Strong)	80.50	11.00	3.20	1.20	1.08	—	—	—	2.38	Smith.
Yellow (Medium)	83.10	9.80	2.70	1.04	0.71	—	—	—	2.03	Smith.
Yellow (Weak)	83.30	7.64	2.59	0.72	0.58	—	—	—	0.92	Smith.
Floor moulding sand (Black)	78.5	4.75	6.00	0.30	—	—	—	—	—	McWilliam & Longmuir.
Staffs. (Red)	85.52	3.72	5.47	0.74	0.52	—	—	—	—	McWilliam & Longmuir.
Glenboig Silica	88.90	4.17	7.43	1.02	0.86	—	—	—	—	McWilliam & Longmuir.
Clyde Rock	85.32	3.74	7.10	0.64	0.31	—	—	—	—	McWilliam & Longmuir.

In an examination of the origin of a sand suitable for moulding purposes, it would appear that much of it was evolved under water, being built up of quartz particles and clay substances (termed by some authorities, Kaolinite), besides felspar, iron oxide, mica, alkaline silicates or chlorides, calcium carbonates and silicates, and organic matter. Many of these substances undoubtedly had their origin in igneous rocks, like granite, after decomposition. All natural

moulding sand, however, was not deposited by water, as apparently some was formed *in situ* by the decomposition of local rock. As is well known, every deposit of sand is not suited for moulding, or even building purposes; and, therefore, during an examination of such sand its origin must be sought, and not definitely assumed to be rock *detritus*. The assumption that every sand is a *detritus* of igneous rock cannot be admitted, because if such a hypothesis be correct, then small stones and flints must also be termed rock detritus, which is scarcely the case, as much of the gravel is formed by an accumulation of silica in more or less liquid form around nuclei, easily demonstrated by breaking in halves stones and pebbles, and examining them under the microscope.

Kaolinite, which represents the clay substance and when incorporated with quartz forms natural moulding sand, is a name given by Johnson and Blake to the minute transparent pearly scales always present in kaolin (the latter being a soft mineral, better known as China clay), in varying quantities. Kaolin and kaolinite are both chemically and physically the same, and Clarke states that the most commonly accepted idea is "that kaolinite is the chief-residual product of felspathic decay," though some writers hold that it is not formed by ordinary maturing. Rosler states kaolinite can only be produced by pneumatolytic action, or, in other words, through the aid of thermal waters and gaseous emanations. Such a theory, however, is open to much argument. In connection with the Cornish and Devonshire china clays, Butler ascribes their formation to an action of hot ascending water, for he found the degree of kaolinisation to increase with depth. Wüst states that the kaolin near Halle gets its origin from felspathic rocks through the action of fumus acids. Some authorities state that kaolinisation often takes place under moors, due to the carbonated waters always present. Stremme refers to the almost self-evident fact that any of the suggested processes may be operative—weathering, pneumatolytic action, and kaolinisation by moor waters, —but ascribes their efficiency in all cases to the chemical activity of carbonic acid. He describes one instance of kaolinisation by the waters of a cold carbonated spring. Selle, however, traces it to ordinary weathering, first sericite, and then kaolinite being formed. The deposit he refers to is richest in kaolin near the surface. Kaolin found on the east side of the Southern Appulachion Mountains is evidently due to the weathering of the pegmatite. In summing up the subject briefly, kaolin, like many other substances, can be formed by any one of several processes, in all of which hot or cold water and carbonic acid take part; no one interpretation is able to fit all its occurrences.

Attempts have been made to artificially convert felspar into kaolinite by decomposition.* The futility of such work is seen from the following:—Daubrèe agitated mechanically 3.0 kilogrammes of orthoclase felspar in an iron cylinder with pure water for 192 days. This yielded about 2.52 grammes of potash, and trifling amounts of silica and alumina. A further experiment by shaking 2.0 kilogrammes of felspar 10 days in water saturated with carbon-dioxide, yielded 0.270 gramme potash, with 0.750 silica. Müller digested powdered orthoclase in carbonated water for 49 days with a resultant solution of 0.1552 silica, 0.1368 alumina, and 1.3257 potash. Such experiments prove that though carbonated water can remove potash from felspars, the time necessary prohibits their use commercially. It can therefore be taken as correct, that felspar and mica are partly decomposed by the carbon dioxide of the atmosphere and of water which comes into contact with them, and the alkaline components are partly carried away, leaving more or less a pure crystalline silicate of alumina, which on hydration becomes kaolinite. This is the natural or geological process, but as previously pointed out, to attempt artificial preparation, or even that of cleaning kaolin artificially, at present is impossible. Writers differ regarding the analysis of pure kaolin, the analysis of two authorities being:—

Authority.	Silica.	Alumina.	Combined water.
Mather ..	.. 46.00	.. 40.0	.. 14.00
Jordan ..	.. 46.4	.. 39.7	.. 13.9

(To be continued.)

* At the time of writing a report has just reached the author that a Swedish engineer named Lindblad, of Copenhagen, has invented a process for making potash from felspar.

The Corrosion of Aluminium.

In a Paper on the "Corrosion of Aluminium," by G. H. Bailey, D.Sc., Ph.D., recently presented before the Institute of Metals, the author confines himself to the consideration of the corrosion of aluminium by water and by solutions of common salt, and gives some of the results of investigations with which he has been from time to time engaged during the past three years. His general conclusions are as follows:—

(1) That in general, the greater its degree of purity, the less is aluminium acted upon by water and salt solutions.

(2) That in presence of copper or sodium the corrosion is notably accentuated.

(3) That where the percentage of silicon is higher than that of the iron, the action is less pronounced in the case of water and acids, and more pronounced in salt solution.

(4) That water and common salt solution, from which air has been expelled, have no corrosive action.

(5) That corrosion is accentuated (*a*) at high temperatures, (*b*) by the presence of impurities in the water, especially alkalies.

(6) That unannealed metal is much more seriously corroded than annealed metal, owing no doubt to the unequal physical condition of the metal in the unannealed state.

(7) That the results obtained by acting on aluminium with acids or alkalies afford no definite indication of its behaviour in presence of water or aqueous solutions. Had it been possible to establish any parallel, the investigation of the corrosion of aluminium would have been much simplified, since the difficulties presented by the formation of suspended or adherent deposit would be eliminated.

Leather Fillets for Patterns.

In a recent issue we referred to the use of leather fillets for patterns and the method of applying them. The fillets referred to were particularly such as supplied by Messrs. Walton & Company, Newton Street, Birmingham, who stock a large variety of these and other pattern-shop supplies such as brass and malleable-iron dowels, rapping and lifting plates, white-metal letters, stamped brass and cast brass letters, and birchwood dowels.

At a meeting of the Newcastle-on-Tyne Branch British Foundrymen's Association on February 22, it was announced that the Branch Council had decided to hold the Branch Annual Meeting in May, and that the meeting was to take the form of a dinner followed by a concert.

Blast-Furnace Plant and Equipment.

By Herbert Pilkington, M.Inst.C.E., M.I.Mech.E.

Before the members of the Sheffield Branch of the British Foundrymen's Association on March 11, Mr. Herbert Pilkington, M.Inst.C.E., lectured on "The Blast Furnace and its Equipment." In the course of his remarks the lecturer said it would be difficult to name any metallurgical appliance which, during the past 50 or 60 years has made such rapid and continuous progress in its development as that of the blast furnace.

Fifty years ago, he said, many blast furnaces did not exceed a make of 100 tons per week, while now makes of 1,000 tons per week are quite common, and in the case of furnaces working on richer ores makes more than double this are produced. The coke consumption at the time mentioned was in many cases as high as 40 cwts. per ton of pig-iron, while now, even with by-product cokes, it rarely exceeds 25 or 26 cwts per ton of pig-iron, and is often, with rich materials, much less than this. Such extraordinary changes in outputs and economy have, of course, only been obtained by vast changes in blast-furnace plant and equipment, almost amounting to a total revolution in ideas of blast-furnace practice.

A blast-furnace plant essentially consists of the furnace itself, three or four stoves per furnace for heating, and the engine power for blowing, but a modern plant is often a vastly more important affair than this. There may be calcining kilns of various types, air refrigerators for freeing the moisture out of the blast, while in addition furnaces may become, as is often now the case, vast gas producers, with pig-iron as a by-product; and therefore the plant may be a huge power station, with enormous gas engines. In the latter case very often a group of blast furnaces may supply power to quite a number of other manufactures extraneous to themselves, such as machine shops, rolling mills in particular, foundries and many other plants. In some instances steam boilers have practically disappeared from the plant altogether, although steam turbo-blowers have given them a fresh lease of life. As a modern blast furnace will produce 170,000 cub. ft. of gas per ton of pig-iron made, it will readily be seen what an enormous source of power blast furnaces have become. It takes at least three times more gas to generate one horse-power by means of steam boilers than it does by means of internal combustion engines, the consumption of gas in the latter being only about 110 cub. ft. Less than one-half of the gas produced is absorbed for heating the blast, so that it is quite evident that there is a large source of power at disposal, and consequently the gas piping surrounding a modern blast furnace has become a very formidable portion of the plant, for this reason, as has also the plant for washing and cleaning the gas, which latter may leave the furnace with a dust content of 6 to 7 grammes per cubic metre. In many new works all the gas is rough washed for the stoves down to a certain point, and then finally washed for the gas-engine consumption down to the negligible quantity of, say, 0.002 gramme per cubic metre. The first cleaning in nearly all cases is done by the dry dust catchers to the greatest possible extent, say, down to about half the original dust content, before passing to the washers—at all events, this is the usual English practice.

One of the greatest features of the modern blast-furnace plant, apart from the utilisation of the gas, has been the extremely complicated mechanical machinery which has been developed for handling the vast masses of materials, and it is noteworthy that nowadays usually each furnace is fed with its own hoist, etc., while the furnaces are also blown separately for the most part, and not from one common blast main, as formerly. In the matter of charging, advantage is taken of gravity in every shape and form, such as by hoppered wagons and bunkers, whilst ground levels, which used to be of such vast importance in the older plants, are not now much thought of, as owing to the machinery used the furnaces are put up practically entirely above ground, including the gas-, water- and waste-mains, platforms and standings being elevated in order to get the slag away from the furnaces by gravity and with the least labour. A comparison of an 1860 furnace with the modern designs is very interesting indeed, while the pig-iron itself, which used to be handled entirely by hand labour, is now mostly handled and broken mechanically, or fed into ladles, and often casting machines are used which these ladles feed, although for foundry pig-iron the latter method is not in much favour.

In short, the modern blast-furnace plant aims at labour saving by all forms of devices which did not obtain fifty years ago. There are now no men employed on the top of the modern furnace for charging purposes, and no fillers at the bottom, as there were at one time, and therefore no shovels and no barrows. A good deal of this progress has been developed as the result of the influence of American practice, where labour was much more costly than here; but the methods are now quite universal to all countries, and blast furnaces are rapidly assuming a stereotyped form and character.

The lecturer then proceeded to give a detailed description of blast-furnace plants, dealing with:—The general arrangement of plants; routine and method of working the plant, fuel, ores, flux, charges, reduction, gas, slag, iron, blast, etc.; heat efficiency; blowing, etc.; gas engnes, turbo-blowers, etc.; and gas-fired steam boilers.

Discussion.

The PRESIDENT (Mr. Thos H. Firth) opened the discussion. He had no idea, he said, that Mr. Pilkington was able to get all his power for nothing. (Laughter.) Pig-iron makers must be having a very good time.

MR. HATFIELD also thought that considering all the economies that had been introduced in the production of pig-iron, its present price was remarkable. Foundrymen who received pig-iron at their works were not concerned very much as to how it was produced; but such a lecture was extremely enlightening as showing the amount of research work and the engineering advance that had taken place in the manufacture of iron. With regard to the composition of pig-iron, in America it was sold by analysis, a practice which was not followed in this country, where a single brand of iron would sometimes vary from 1.5 to 3.5 of silicon. He would like Mr. Pilkington to throw some light on that matter. Was there any real difference in the uniformity of the product in America as compared with this country?

DR. RODGERS said he was very much interested in Mr. Pilkington's description of the hot-blast valve; it was certainly a very interesting problem to make

a valve of that kind work at a red heat. One got something of the same kind in the Siemen's furnace. He would also like Mr. Pilkington to tell them what was the most usual method of making a wear-resisting section at the top of the furnace.

MR. REDMAYNE asked, with reference to the cycle of operations described by Mr. Pilkington, how it would be first started. There was no such "cycle of operations" thirty years ago, and pig-iron was then half its present price, and there was not then the by-products.

MR. MIDDLETON could not quite follow Mr. Pilkington's argument that an efficiency greater than 100 per cent. was obtained. Did he mean thermal efficiency, mechanical efficiency, or overall efficiency? He could not see that they could get more work out than the fuel put in.

MR. PILKINGTON, replying to the discussion, said he had just been making the rough-and-ready calculation as to modern coke, that with 10 per cent. volatile matter, 10 per cent. water and 10 per cent. ash, there was only 70 per cent. of fixed carbon left. But at one time they could buy no end of beehive coke with only 16 per cent. of impurities, leaving 84 per cent. fixed carbon—or he would be content to put it at 80 per cent.—to go right down the furnace, for nothing was of any use in a blast furnace for smelting except the fixed carbon; it was the gassification of fixed carbon that did all the work except the gas production at the top. In reply to Mr. Middleton, the thermal efficiency he would put at 70 per cent. in the furnace itself; the other could be reckoned out of the gas produced—170,000 cub. ft. of pig-iron made. Blast-furnace people were now suffering from the fact that they were working a very much leaner ore than formerly in the districts working Lias and Oolitic ores. With regard to dividends, he was of opinion that the vast capital expenditure on blast furnaces was killing itself. If they allowed for depreciation, upkeep and repairs, he thought that the Americans had overdone it, and had taught them in England to do so too.

He had always been opposed to buying foundry pig-iron by analysis, but for other pig-irons a definite specification was used. The difficulty had always seemed to him to be in the extremely varying ideas about pig-iron which the founders themselves had. The smaller the ironfounder the worse they were. It was extremely difficult to fit things in and run one blast furnace alone to fit the widely differing requirements. When ironfounders had educated themselves up to knowing their own requirements they would get pig-iron as they wanted it. But as long as there were just a few in the wilderness, those few would have to make their own arrangements. It was a very peculiar thing that all American pig-irons were lower in silicon than English. He admitted that there was a variation with regard to the silicon in pig-iron, and feared it would always be so with the apparatus they had, but there was not half the variation with the modern furnace as with the earlier one—the quantities were too vast in the modern furnace. He would like to know why the top and bottom of the casts produced a different silicon to the middle. Why did the mere act of casting alter the silicon? Perhaps the learned doctors would throw some light on this.

The hot-blast valve was the result of a large number of changes; the size was a 22-in. orifice, and it was worked by double-geared wheel gearing. It was of soft cast iron. With regard to the section at the top of the furnaces, the Maryland was of cast steel 3 in. thick. In the latest he had adopted—but not yet worked—1¼-in. rolled-steel plates very considerably stiffened with angle and T irons. As to the cycle of operations, he quite agreed with Mr. Redmayne that there must always be something to begin with, but blast furnaces were always worked in couples, and when one was not working the other was.

On the question of the chemical analysis of iron, they must not forget that all blast furnaces were limited by the class of material available within a commercial range, which influenced the amount of phosphorus and manganese; the carbons were simply a matter of furnace conditions.

At the conclusion Mr. Pilkington was heartily thanked for his lecture, on the proposition of the PRESIDENT.

Hot Panel and Hot Floor Border System of Heating.

At a recent meeting of the Junior Institution of Engineers, Captain H. Riall Sankey, R.E., M.Inst.C.E., gave a lecture on "Hot Panel and Hot Floor Border System of Heating," in which he said that the dominant feature of the new method is the use of radiant heat rather than the heating of the air. The fact is often lost sight of that the object of heating a building or room is to make people comfortable; hence it is usual to specify that the heating power and heating surface shall be sufficient to maintain the temperature of the air 5 ft. from the floor at a specified temperature of, say, 63 deg. F. The result has been that most of the systems hitherto adopted have been devised so as to heat the air, and radiant heat has been, to a large extent neglected. It is generally conceded that for comfort, when sitting in a room without a fire, an air temperature of about 63 deg. F. is needed, and in order to obtain this temperature the surfaces of ordinary radiators require to be at the fairly high temperature of, say, 150 to 180 deg. F.; this temperature, however, decomposes the dust in the air thus producing a disagreeable and characteristic smell. When radiant heat from a fire is available the air temperature can be as low as 55 deg. F., or even 50 deg. F., and yet the sense of comfort and warmth is greater than in the previous case. To maintain the temperature of 50 or 55 deg. a hot-water system of heating or the like will, however, be required in many cases. Such a system, although ideal, is more costly. Now the hot-panel and hot-floor system does not unduly heat the air as it supplies the radiant heat needed for comfort. A hot panel consists essentially of a small pipe bent backwards and forwards and imbedded in a semi-conducting composition; half-inch, drawn, lay-welded steam pipe is used. The heat carry medium, say, hot water, circulates in the tube, and the heat is conducted through the walls of the tube to the composition, through which it spreads to the surface of the panel, whence it is radiated into the room; in effect heat at a comparative high temperature issuing from a small surface is converted into the same amount of heat at a lower temperature issuing from a large surface. A hot panel may contain more than one length of tube, in order that the flow in each length may be controlled by external valves. A hot panel can be made up in an iron frame, thus forming a detached unit similar to the ordinary radiator, or it may be built up against a wall very nearly in the thickness of the plaster. Hot borders are formed by placing drawn, lay-welded half-inch pipes about an inch below the level of the floor, close to the walls, around the whole or part of a room, and imbedding these pipes in semi-conducting composition.

The Function of the Slag in Electric Steel Refining.*

By Richard Amberg (Crucible Steel Company of America).

The function of the slag, of course, depends on the kind of work which the furnace is desired to perform, and this depends on the cost of power. In localities where power is cheap, the electric furnace may be used for carrying out reactions which in other places with more expensive power would be carried out more cheaply in an oxidising furnace, like the open-hearth. At places where cheap power is available, electric steel melting begins with the widely-known open-hearth process of melting pig and scrap. Assuming a basic-lined bottom and hearth heated by one or more electric arcs, the charge melts down, slag is formed by lime, silica, and iron-oxide in the form of ore, or scale, and the refining by oxidation takes place in form of heterogeneous reactions of different kinds. After the ferric oxide dissolved in the slag has been reduced to ferrous oxide, it partly acts directly on those parts of the metallic solution which come in immediate contact with it, and partly dissolves in the metal according to temperatures and co-efficient of division of FeO between the two liquid phases (metal and slag). If the slag is saturated with FeO, the latter can assume its full concentration in the metal bath according to the solubility curve. Its action there on manganese and the metalloids is much the same as in the open-hearth. It can be more energetic, however, if the operator avails himself of the facility of a higher temperature, which is a special feature of the electric furnace, and of a higher concentration of FeO.

There is one essential difference from the reactions in an open-hearth slag. In a well-built electric furnace, practically all the oxygen required has to be supplied in solid oxide form, while the open-hearth has an unlimited supply of oxygen in the air supply.

At this period of oxidation the basic slags of an arc furnace and of an induction furnace show a material difference; the dephosphorisation, being a process which reaches its maximum velocity at a temperature somewhat below the melting point of soft iron, is accomplished more quickly in the comparatively colder slag of the induction furnace than under the higher heat of the arc. The technical significance of this fact, however, is small.

The analysis of the slag during this period does not offer any particular interest in comparison with open-hearth slag. CaO will run in the neighbourhood of 40 per cent., sometimes 5 to 8 per cent. lower, iron and manganese oxides 26 to 29 per cent. together, and the silica will vary with the silicon of the charge and the additions. P_2O_5 may run up to any amount in crude open-hearth work, yet, as a rule, the slags have been skimmed when it reached something like 4 per cent. As manganese ore, even at this stage, helps desulphurisation, it seems to act locally, perhaps near the electrodes only.

As explained before, this dephosphorisation process may be carried out in an ordinary non-electric furnace. When it is finished, then begins an entirely new operation—the deoxidation of the metal. This involves a slag process which none of the other furnaces can perform. Carbon is the chief deoxidising agent and is bound to act in both phases.

With electric heating it is possible to heat the slag with the addition of carbon in a reducing atmosphere so quickly that it forms a high endothermic compound of calcium and phosphorus, probably Ca_3P_2, which is not reabsorbed by the steel phase; hence the opportunity to dephosphorise without skimming the slag. How sensitive this reaction is with respect to temperature is shown by the fact that without very accurate control of the temperature a rephosphorisation of the metal has been found.

Since in the reducing atmosphere, when carried on far enough, the partial pressure of oxygen is very low, the oxygen can be removed to a considerable extent from both phases without disturbing the equilibrium at the contact surface, while the opposite would be the case with an open-hearth furnace. In fact, the amount of FeO present in the final slag is easily brought down in everyday practice to between 1 per cent. and 0.5 per cent., and with a little attention considerably lower. The reaction by which this is performed is a true heterogeneous one (that is, a reaction between the metal and the slag at the points of contact) and consequently does not come to an equilibrium in the original phase; FeO as a base of the silicates or as dissolved in the slag is freed from oxygen and the metal joins the other phase. Manganese is practically removed from the slag in a similar way. Even silicon is partly reduced, when the basicity of the slag and the temperature are both high enough.

In the oxidising period, where sulphur is being removed only to a small extent in the open-hearth, the electric furnace is much more efficient in this respect, especially when manganese ore is used. It is likely that a good bit of the sulphur forms SO_2 and disappears with the gases; as the partial pressure of O and SO_2 in the atmosphere of the electric furnace is smaller than in the open-hearth, the reaction takes place more easily.

In the reducing period a new desulphurising action takes place, according to Dr. Amberg, as follows:—

(1) $FeS + CaO + C = Fe + CaS + CO$ at the high temperatures of the arc furnace.

(2) $2\,CaO + 3\,FeS + CaC_2 = 3\,Fe + 3\,CaS + 2\,CO$ at still higher temperatures, where calcium-carbide can be formed.

(3) $2\,FeS + 2\,CaO + Si = 2\,Fe + 2\,CaS = SiO_2$ at the lower slag temperatures of the induction furnace.

(4) $CaS + FeO = FeS + CaO$. This equation occurs from left to right for comparatively small amounts of oxygen, while from right to left it is the underlying principle of the three reactions, 1 to 3.

In all the foregoing reactions one feature deserves the most important consideration, that is, the high basicity of the slag; this, in turn, is made possible by the high temperatures attainable, especially in the arc furnaces.

The elements which in the present electric furnace practice take care of reducing the oxides are chiefly carbon in the arc furnace and silicon in the induction furnace. The manganese is practically eliminated altogether, and the FeO easily removed down to 0.5 per cent.; nickel is reduced with great ease, chromium, tungsten, and vanadium according to their inherent amount of free energy with a larger consumption of power.

* Read before the recent International Congress of Applied Chemistry, at New York

To explain the mechanism of the reactions it is best to consider them as reactions in a system of different phases (two liquid, metal and slag, the third gaseous, and the fourth, namely the hearth of the furnace, solid). It is of great importance for the advancement of general metallurgical knowledge to determine the melting points of the pure compounds and give the complete diagram of the melting point of their mutual solutions over as wide a range of concentrations as possible. Much remains to be done in this field. Some important melting points are as follows :—$FeSO_3$, 1,050 deg. C.; $MnSiO_3$, 1,150 deg. C.; $CaSiO_3$, 1,220 deg. C. to 1,225 deg. C.; $MgSiO_4$, 1,400 deg. C.

The carbon thrown into the furnace and the carbon derived from the electrodes can produce several compounds. Prevalent among these are silicon carbide, calcium silicide, and calcium carbide. This latter one seems to be the most persistent under operating conditions, and is recognised by the development of acetylene from a cooled-off sample. It is only after this carbide has been formed to a certain extent that the deoxidation of the charge can be relied upon as completed.

When this condition of the bath has been realised, the electric furnace represents the nearest approach to the ideal heterogeneous equilibrium between the different phases which has hitherto been accomplished in large-scale metallurgy; converter and open-hearth are under the action of air and gas, the crucible metal takes carbon and silicon up, and in the electric furnace the action of the metal on the basic lining is almost nil, while there is no exchange of elements between metal and slag. However, a small evaporation of participants of the slag takes place, and in this respect the induction furnace with its cold slag has a slight advantage over the arc furnace.

Under certain working conditions of operation of an arc furnace, when it is thought advisable not to cover the electrode holes in the arc airtight, fumes can be seen passing through the small joint between electrode and roof brick. These fumes always leave a deposit on the cooler parts of the electrodes, in powder form. An analysis of them taken during the oxidising period of a furnace showed, aside from minor quantities of other substances, SiO_2, 4.50 per cent.; FeO, 8.49 per cent.; Fe_2O_3, 60.60 per cent.; CaO, 8.10 per cent. This composition allows the conclusion that after reducing the metallic oxides from the slag there will be a considerable volatilisation of CaO and some less volatilisation of SiO_2, both being probably first volatilised as elements and then oxidised in contact with the atmosphere. Smaller lots of Si may perhaps take part in the desulphurisation by forming SiS_2, a volatile compound, and then decompose in contact with humid air or water.

The author then takes up the physical aspect of the fact that there is by no means an ideal two-dimensional contact surface between slag and metal, and that both phases penetrate each other to a considerable extent. The prevailing idea that slag and metal behave like oil and water is only relatively true. The slag swims on the metal, but where small parts of the one are caught in larger masses of the other, they have to overcome an enormous friction in order to be separated, and the smaller the slag particles the more difficult is their separation from the metal bath. It is, therefore, very important to keep the finished charge quiet and at a sufficiently high temperature to allow it to settle. Thereafter proper precautions have to be taken while teeming and pouring, that the painstaking results of refining may not be reversed.

This slow physical action may furnish a new explanation for the slow progress of the desulphurisation according to equation 2 (above). The microscope shows that siliceous and sulphide products are sometimes contained down to two-thirds, and even lower, from the top of an ingot. These non-metallic products appear as balls in the ingot structure, and are elongated into a cigar-like shape after rolling or forging the metal. Although the melting point is lower than that of steel, they have not succeeded in uniting with the bulk of the slag in proper time. Consequently there is a lack of material in the slag, and desulphurisation can only take place whenever new sulphides are supplied.

The author concludes with a brief discussion of the acid-lined electric steel furnace. An acid lining requires an acid slag to keep the hearth in good condition. This acid slag will be much the same as the slag of an acid open-hearth, as long as the charge is treated with an excess of oxides and the heat not exaggerated; if necessary, it can be made to contain a higher percentage of SiO_2 for the same reasons which hold good for highly basic slags. The great difference from the basic electric furnace is, in this case, that all four phases are in lively reaction with each other, that conditions approaching a status of equilibrium cannot be reached, and that the metal must be "caught" at a certain moment for teeming.

The solid and the metal phase react in this way, that carbon of the bath reduces Si from the hearth, the amount of Si present being regulated by a reaction between the two liquid phases, namely, by keeping a sufficient stock of oxides in the slag to hold the Si within the required limits. The slag will therefore be a thoroughly black one, particularly during the beginning of the run. Thallner ascribes a specific beneficent effect to this exchange of Si and to the low heat conductivity of the silica lining. Towards the finishing of the acid heat the colour of the slag clears up, and its reduction finally reaches a point where the glassy masses become light grey and green coloured. Sulphur will, as in the acid open-hearth, remain unaltered in quantity, while phosphorus may be slightly decreased by phosphoric acid being thrown out of solution by the stronger SiO_2 and then reduced to phosphide of iron. This has to be confirmed, however.

It may be that some of the advantages of this method are due to the mechanical property of the slag to agglomerate more easily than the basic slag particles to larger globules, which force their way up to combine with the bulk of the slag.

Sound Ingots.

At the recent meeting of the American Institute of Mining Engineers, an electrical method of eliminating pipes and segregation was described by Mr. G. H. Clamer, of Philadelphia. The process involves keeping the top of the ingot molten by the employment of the principle upon which the Hering electric furnace is operated, namely, the production of heat in a body of liquid metal, the dimensions of which are so restricted that a current of high current density forces through it, producing the pinch effect. This automatically expels the metal from the centre of this restricted body of metal, causing it to flow in gradually around the periphery of the ejected core of the liquid. The device practically is a furnace or heater of the resistance type, using liquid as the resistor. The pinch effect principle of operation is being incorporated in four electric furnaces for refining steel, which range in capacity from one to three tons. The device for heating the ingot tops consists of a transformer direct-connected to metallic electrodes and a block of magnesite in which the resister holes are placed. It has been concluded that transformers with capacities of from 10 to 50 kilowatts would take care of practically all commercial sizes of ingots. The current is transformed from 110, 220 or 440 volts to 4 to 6 volts, with a corresponding increase in the amperage

Some Failures.

By H. Sayers.

While we may not wish our friends to have misfortunes, we always like to hear of them when they do occur. This may account for the interest taken in the subject of wasters, that is when "the other fellow" has them. The causes of the various troubles illustrated herewith were fairly obvious afterwards. It was, in each case, a matter of lack of thought. They are examples from jobbing-shop practice.

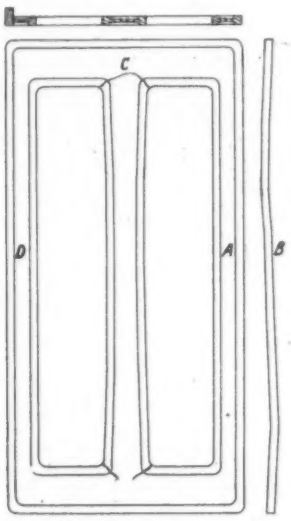


FIG. 1.

Fig. 1 is a casting of light section, 8 ft. long by 4 ft. broad. The pattern had been in the shop on previous occasions, and as no trouble had been experienced in filling the orders none was anticipated. The present order was for four, and when the castings were got out, three of them were bent along the side A (somewhat exagerated at B) to the extent of an inch or more, while one was cracked across one end at C, and partly across the other. Investigation showed that, while on previous occasions the castings had been run from the ends, this time they had been run with spray gates into the broad centre portion, with the result that while the sand near the runners was heated up by the passage over it of the metal,

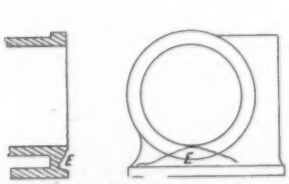


FIG. 2.

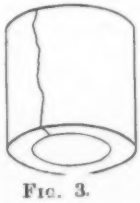


FIG. 3.

the latter was cooled by its long journey before coming to rest in the narrower side portions. The metal had set and finished contracting before the centre portion had commenced, so that the latter could only contract by shortening the sides, or by pulling away from the ends, and the side D, being stiffened by the rib cast on it, the necessary shortening had to be got by bending A.

Fig. 2 is an end view and part section of a locomotive cylinder. When the casting was got out a sort of shell was found at E, and when that was broken away a depression appeared over the facing where the sand had been forced into the mould, a defect sufficiently serious to cause the casting to be scrapped. The mould was cast on end, with the defective end up. In ramming up the mould the moulder had laid a long ¼-in. rod into the narrow groove between the flange and facing. There was very little sand covering the rod, with the natural result that the latter very quickly got hot and commenced to expand before the metal was set. The ends of the rod were held fast in the sand, away from the metal, so that the expansion caused the rod to bend at its hottest part, which was at E, forcing it into the mould, and,

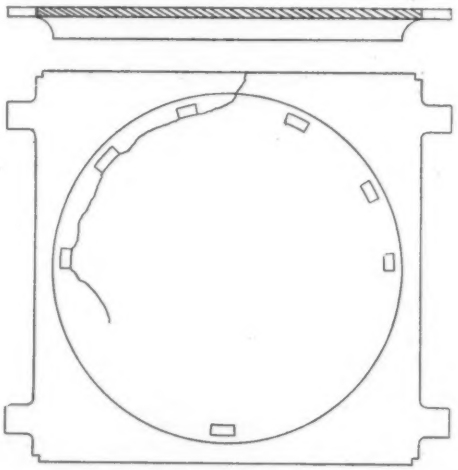


FIG. 4.

of course, carrying the sand with it. If grooves like this must be rodded it is better to stick bits of rod or nails in endways; not full length.

Trouble has been experienced on somewhat similar lines with the core barrels used in casting hydraulic rams, when the barrels were held down from the top and not released in time. It is as well in such cases to have the barrels of strong section, but as small in diameter as possible, consistent with getting off the air, as the smaller the barrel the greater the thickness of loam, etc., and the longer will the heat be in penetrating to the barrel.

Fig. 3 is a ring of metal, depth 12 in., diameter 13 in., thickness 2½ in., cast in a chill with a dry-sand core. The thickness of chill mould was only 2⅜ in. Several of these were cast on different days, and fed (a totally unnecessary operation), and all of them showed a vertical crack extending through the chilled portion ½ in. to 3-16 in. On casting them without feeding, however, they came sound, the reason evidently being that the light chill mould speedily became hot and expanded away, leaving the thin skin of chilled metal unsupported, so that the latter was burst by the pressure exerted by the feeding rod.

Fig. 4, a loam plate, 6 ft. 6 in. square, used to cover a dry-sand job, made in boxes, the depth of which necessitated a 6-in. drop joint on the loam plate. After being finished the mould went into the stove with the plate turned over, so that the joint was up. The plate was sound when put into the stove, but came out with a crack running nearly half way round it. It had been cast in the manner usual with loam plates, that is, no attention was paid to it to ensure equal cooling, so that the middle of the plate cooling last, was exerting a pull on the outside, and, when stoved, the middle portion, being kept cool by the amount of sand on it while the edges were exposed to the hot gases, expanded until the strain passed the breaking point, a not unusual result, and one which ought to impress on everyone in charge of such work the necessity of covering up the edges of such tackle and taking steps to ensure that all parts cool together when cast.

The Microscope in the Foundry.

Before a recent meeting of the Newcastle-on-Tyne Branch of the British Foundrymen's Association, a Paper was read by Mr. W. Patterson, of West Hartlepool, on "The Microscope in the Foundry." The Paper had for its object the illustration of the widely different structures of metal from the same ladle after subsequent trials, such as the metal actually undergoes in the foundry.

In the course of the discussion which followed, several questions were put to the lecturer. Mr. Richardson asked if the lecturer would tell him as to the best kind of instrument to use, and its cost; also how any beginner could learn microscopic work in the shortest way? What help would the microscope be in connection with sulphur and with sands, and possibly also with coal dust and blacking. Mr. Patterson had told them that in dealing with phosphorus eutectic there was a difficulty in regard to coal dust and blacking. Would the microscope help them in regard to that? Also would it help them in finding out the porosity in a casting?

Mr. Paulin said that he noticed in a table exhibited by the lecturer, that between the numbers 9 and 10 there was a marked change in the combined carbon. Was that the danger zone? He asked this because he had often noticed more porous and open metal in the thinish portions where the grain should be closer than in the thickest sections. Was it Mr. Patterson's experience that where the silicon was above 2 per cent. there was a likelihood of getting just at the juncture of the small section and the large section such a great strain on the metal as to produce segregation.

Mr. Richardson asked what was meant by these various compounds—pearlite, cementte, and martensite? Were there different eutectics or only the one they knew as phosphide eutectic?

The Chairman asked whether in filling a mould one could get two different qualities of metal in the one casting? Also, he was puzzled to know how, when the same quantity of metal was used, the same test was not got from one bar as from another? He was speaking especially of propeller work.

In reply, the lecturer said that in the blade of the propeller the cooling was more rapid than with the base, and this accounted for the difference in strength which was experienced in this kind of work. As to whether metal varied when it was being filled into the mould, that was possible, but not very likely when the casting was poured at the ordinary rate. As to the choice of instruments, there were several good ones on the market, and he thought £7 ought to get them a very useful microscope. As to approaching the subject, that was a big question. But it was not so difficult as it seemed. First of all, the specimen should not be bigger than a quarter of an inch square. It should be run down with a file, faced with emery and finished off on a piece of cloth. A bottle of the final polishing medium, costing 1s., lasted him three years. With regard to sulphur, the microscope would particularly help them. Porosity was easily revealed under the microscope, providing a small section were chipped off, for the porous parts were generally under the skin. As to the eutectics, they were the compounds that remained when the others had crystalised out, and consequently they varied very considerably. The eutectic was that portion of the liquid alloy which was the last to solidify. There would naturally be certain substances with a lower melting point than the others, and consequently these would form the eutectics. Graphite was never found in the eutectic. A question had been asked regarding a critical point in the silicon. He had mentioned that probably the sudden change was due in part to the conditions of the metal, and one could safely say that about that point silicon began to react very seriously, and to separate the graphite almost entirely. As to the learner, he admitted that he would not find the constituents very characteristic at first, but that difficulty would soon be got over. When it came to the difference between ferrite and pearlite, the student would either have a big difficulty or none at all, for if the pearlite was developed well its structure was so unmistakeable that there was no question about it. A question had been asked as to whether with silicon above 2 per cent. the grain was likely to be open. The answer was yes, though that did not mean that the metal was necessarily weak. He had tested metal containing 2 per cent. of silicon, and had regularly got a tensile-test result of from 10 to 15 tons.

Methods of Packing Ferro-Silicon.

In a recent American Consular Report, the Swedish firm, the Gullspangs Eletrokemiska Aktiebolag, describe their methods of packing ferro-silicon. "For packing," they state, "we principally use iron-bound wooden cases in two sizes, one (for 50 per cent. ferro-silicon) containing about 287 lbs., and one (for 75 per cent.) holding about 353 lbs. The boxes have always been unlined, and were made at first of unrabbeted ⅞ in. stock, but since last year we have employed rabbeted stock, as the loss of contents in transit was found to be too great with unrabbeted boards. Water-tight packing being required for Germany, we pack goods for that country in second-hand paraffin barrels; these are, of course, both water- and gas-tight, but no fault has been found with them. On all our very latest shipments we have, at the request of foreign sellers, begun to pack ferro-silicon in sheet-metal cylinders containing about 375 lbs., and have made four holes 0.276 in. diameter in the top to provide against excessive pressure in the cylinders. The regulations in force are different for different countries (*e.g.*, for transport on some English railways each package must have three 1-in. holes to permit the escape of any gases that may form). In our opinion, the dangers connected with the transportation of ferro-silicon can never be entirely avoided until uniform international regulations are adopted. In this connection it should be noted that danger is present only when the silicon content is between 35 and 65 per cent.; under and over these proportions ferro-silicon is much more stable. So far as we are informed, accidents have never happened except with about 50 per cent. If, as we hope, an international regulation regarding packing and transportation can be established, regard should be had to the last-mentioned fact, and different regulations adopted for 25 per cent., 50 per cent., and 70 per cent. goods, or those of higher percentages."

Institute of Metals.

The annual general meeting of the Institute of Metals was held at the Institution of Mechanical Engineers on March 11 and 12.

Presidential Address.

In the course of his inaugural address, the newly-elected PRESIDENT (Prof. A. K. Huntington) remarked that metallography was one of the newer subjects in connection with the study of metals to which the Institute had paid, and would continue to pay, special attention. The knowledge to be gained from the chemical analyses of alloys was very small compared to what could be obtained by studying the internal condition and structure when the composition was varied and they were subjected to mechanical or heat treatment. It was the rapid growth of metallography and chemical physics which had called the Institute of Metals into existence.

Regarding the bringing together of manufacturers and users of the non-ferrous metals and scientific men, an analysis of the membership showed that the percentages of members from these three classes were respectively 37, 34, and 29 per cent. But an analysis of the papers read before the Institute told a very different story; of these, manufacturers had contributed only 9¼ per cent. and users 15½ per cent., leaving to the credit of the professional members of the Institute 75¼ per cent. of the papers read. This was to be regretted. The position between manufacturers and users was always a very delicate one. What was required was more mutual confidence. Manufacturers were at an enormous disadvantage in not being able to obtain readily and continuously information as to how their material was behaving in service, and above all as to the conditions to which it was being subjected in use. The difficulty of obtaining information from users arose not merely from the unwillingness of users to give it, but from the fact that frequently users had not got the information. There would not in future be the same excuse for the absence of this knowledge, because the requisite training was now open to young engineers and works' chemists.

Report of Council.

In their annual report the Council state that the year 1912 marked a period of material development in the activities of the Institute, and a slight growth in the membership. The number of members on the roll at December 31, 1912, was as follows:—Fellow, 1; honorary members, 4; ordinary members, 586; student members, 23; total, 614. The Council have conferred on Professor H. Le Chatelier the honorary membership of the Institute.

The report states that considerable progress has been made in the investigation of the causes of corrosion of tubes of the four types of alloy selected by the Committee, namely, 70 : 30 brass, Admiralty mixture, lead-bearing brass, and Muntz metal. Twelve tubes of each alloy have been tested in the special condenser plant for nine months, i.e., from April to December, 1912. Three tubes of each composition have been withdrawn for detailed examination; this, however, has not yet been completed. A preliminary examination has shown that a small amount of corrosion, such as that usually met with in tubes that have failed in practice, has occurred in some of these tubes, but has not penetrated to any considerable depth. All the tubes have been found to be covered with a scale of composition similar to that typical of those used in the mercantile marine. Investigation on these tubes is still proceeding. The plant itself was closed down temporarily on December 31, 1912, pending the supply of further funds for working expenses, which amount to about £100 per annum.

An extensive scheme of laboratory experiments has been devised with the object of elucidating the nature of reactions which take place during the processes of corrosion and scale formation. It has been found necessary to continue a number of the experiments for periods of several months, as the collection of data is necessarily slow. Hitherto it has not been possible to devise any satisfactory "acceleration" test, so work in this direction has been abandoned for the present. A considerable number of badly corroded tubes have been sent in for examination by various shipping firms and manufacturers, and afforded useful information. The investigator is now desirous of obtaining a number of tubes that have endured exceptionally long service in marine or land condensers.

Nomenclature Committee.

As a result of a suggestion contained in Dr. Rosenhain's Paper, "A Note on the Nomenclature of Alloys," read at the annual general meeting in January, 1912, the Council appointed a Nomenclature Committee to consider the re-naming of certain of the non-ferrous alloys. It was thought desirable by the Council that the Committee should number among its members officially appointed representatives of other Institutions, and this has been arranged, the constitution of the Committee being as follows:—

Institute of Metals.—Dr. W. Rosenhain, B.A. (Chairman), Mr. G. A. Boeddicker, Dr. Cecil H. Desch, Engineer Rear-Admiral G. G. Goodwin, R.N., Mr. G. Hughes, Sir Gerard Muntz, Bart., Mr. A. E. Seaton, and Professor T. Turner, M.Sc.

Institution of Electrical Engineers.—Mr. W. Murray Morrison.

Institution of Mechanical Engineers.—Mr. George Hughes.

Institution of Naval Architects.—Sir W. E. Smith, C.B.

Institution of Engineers and Shipbuilders in Scotland.—Mr. Alexander Cleghorn.

North-East Coast Institution of Engineers and Shipbuilders.—The Hon. Sir C. A. Parsons, K.C.B., F.R.S.

Society of Chemical Industry.—Professor W. R. Hodgkinson, Ph.D., M.A.

Delegates to Conferences.

In connection with the International Congress of Mining and Metallurgy, Applied Mechanics, and Practical Geology, 1915, Professor W. Gowland, F.R.S., Sir Gerard A. Muntz, Bart., Dr. W. Rosenhain, B.A., and Mr. G. Shaw Scott, M.Sc., were appointed by the Council to act as the representatives of the Institute. The Council have guaranteed the sum of £50 towards the expenses of the Congress.

The financial year opened with a credit balance of £456 5s., and closed with a balance, also to credit, of £563 10s. 11d., showing an increase of £107 5s. 11d.

Abstracts of some of the Papers presented at the meeting are given in this issue.

Practical Heat Treatment of Admiralty Gunmetal.

By H. S. Primrose (Messrs. G. & J. Weir, Limited, Cathcart), and J. S. G. Primrose (Royal Technical College, Glasgow).

In his Paper to the Institute on a former occasion,* one of the authors made the suggestion that if gunmetal were subjected to heat treatment, such as quenching and annealing at various temperatures, profound changes would be found to take place in the properties of the metal. Since then this joint research has been undertaken with the object of finding a simple and reliable method of improving Admiralty gunmetal so as to obtain the highest possible tensile strength without reducing the percentage elongation, and at the same time imparting to it a greater soundness and homogeneity of structure. So far as the authors are aware, no previous work has been published dealing with this subject as applied to the most commonly used industrial alloy known as Admiralty gunmetal, of which the specification is 88 per cent. of copper, 10 per cent. of tin, and not more than 2 per cent. of zinc, with a maximum variation of 1 per cent. of any of its component metals. This composition is readily obtained in practice which is under proper metallurgical control, but even when the analysis closely agrees with the specification it is sometimes difficult to produce castings which fulfil the requisite physical tests attaining a tensile strength of 14 tons per sq. in., and an elongation of 7.5 per cent. on a 2-in. test bar. Many practical founders and some experimenters have experienced considerable trouble in making sound castings with this alloy to stand a high water pressure; and undoubtedly the internal structure of the metal has a great deal to do with this important property, as well as with the other characteristics.

Although blow-holes are the commonest known source of unsoundness in gunmetal, these may be entirely absent and still the castings are not completely satisfactory when submitted to the physical tests and hydraulic pressure, owing to the imperfect arrangement of the constituents. Even when the physical tests are complied with and the structure under the microscope is of the interlocking design with uniformly intermixed primary crystallites and interspacial eutectic, the metal as cast may fall under water pressure owing to the water sweating through the microscopical pores formed between the two constituents. These constituents are of widely different chemical composition, and possess different coefficients of contraction. With a view to investigating the subject, the authors procured a number of 1-in. round bars 10 ins. long, and these were subjected to an extensive series of experiments by quenching and annealing and thermal analysis.

In view of the excellent results obtained by Guillet on quenching pure bronzes of various composition, from temperatures between 600 degs. C. and 700 degs. C., it was thought that gunmetal would also show an increase in the strength and the elongation if similarly treated. This, however, was not found to be the case, as there was a considerable reduction in the values got on tensile testing, and evidently the presence of the small proportion of zinc exercises a profound influence on the character of the metal.

However, the importance of the annealing of gunmetal castings, which in service have to stand severe tests, was abundantly evident from the experiments. One great advantage it possesses lies in making the metal capable of complying with the most stringent specification as regards tensile strength and elongation, although it must be clearly pointed out that it cannot be regarded as "faking" the metal. Such metal as may be defective, due to the pressure of gas or blow-holes, is not materially improved by this heat treatment; but when slight defects arise, due to the harmful segregation of the eutectic structure, then this is completely removed by the proper annealing.

One of the most frequent tests now applied to important gunmetal castings is that of water pressure, and in many cases they fail most dismally under even moderate pressure. The metal is thus condemned as bad, whereas it is really quite good, and it is only a strange characteristic of the metal possessing the wrong arrangement of its constituents which makes it unsuitable for this purpose when cast and not further heat-treated as suggested in this Paper. Numerous castings of various designs made in the course of daily foundry practice have been rejected in this way, and these, on being annealed correctly, have in all cases been found to withstand the water pressure which previously they had failed to do.

Two particular instances are worth recording as showing the advantage of annealing material which, although apparently sound, has failed to comply with specified tests. They were both test bars cut from large castings, and whilst the first gave a tensile strength of 14.4 tons, the elongation was only 5 per cent. when normal. On annealing this at 700 degs. for thirty minutes the tensile strength was raised to 18 tons and the elongation was increased to 25 per cent. In the second case both the tensile strength and elongation were low in the normal bar, being 11 tons and 8 per cent. respectively. This metal was improved by annealing to give the remarkable results of 15 tons tensile strength and 26 per cent. elongation. In putting this annealing process into practice in the workshop or foundry the chief item required is some type of muffle furnace of a size large enough to hold a number of the castings to be treated. For maintaining a uniform temperature during the annealing, as also for regulating the rate of heating and cooling, it is necessary to employ either gas or oil firing. The temperature must be controlled by a pyrometer installation, and the workman in charge of the operation should be under supervision to ensure that he does not exceed either the temperature or time limits found to be needed for each class of casting under treatment.

As the result of recent researches with the brasses and bronzes it has been shown that one most serviceable method of getting over the trouble of corrosion is to eliminate the presence of all eutectic from the structure. This is accomplished by the addition of other metals in the production of proprietary "alloys"; whereas it would appear that gunmetal

* "Metallography as an Aid to the Brassfounder," by H. S. Primrose, "Journal of the Institute of Metals," No. 2, 1910, vol. iv.

may be quite as immune from such trouble by the simple operation of annealing, whereby the eutectic is destroyed.

The authors take this opportunity of expressing their warmest thanks to the firm of Messrs. G. & J. Weir, Limited, of Cathcart, for kindly granting the use of their extensive foundry and equipment in carrying out this research, and also for so magnanimously granting permission for the publication of the results, which the authors hope will have far-reaching effects in the practice of gunmetal founding.

Summary.

The heat treatment of Admiralty gunmetal has been investigated by quenching and annealing bars cast in dry-sand and chill moulds. The treated metal was tested physically and examined microscopically.

(1) The tests show that no improvement may be expected by quenching, which lowers the strength of the material.

(2) Simple annealing of the metal for 30 minutes very considerably increases its strength and elongation, the maximum results being obtained after annealing at 700 degs. C

(3) The homogeneity and other physical properties of the metal are correspondingly improved, but particularly the capability of the castings to withstand hydraulic pressure.

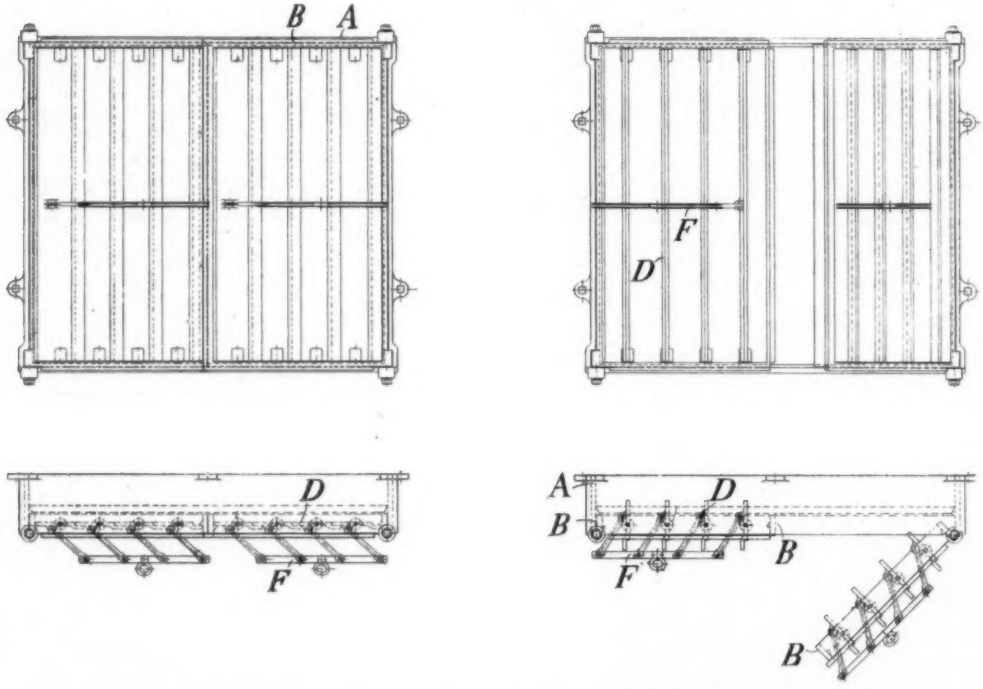
(4) These results are considered to be due to the removal of the eutectic from the microstructure, which after annealing shows only the crystals of *a* solid solution.

(5) It is anticipated that this heat treatment will minimise corrosion difficulties.

Air Controller for Melting Furnaces.

The apparatus illustrated, of which the patentees and manufacturers are Messrs. M. & W. Grazebrook, Netherton, near Dudley, has been designed for controlling the air supply to reverberatory melting furnaces. With faulty air control, the fuel consumption may easily be quite out of proportion to the work accomplished; in such circumstances there is, in fact, a continual waste, with the possibility of burning and spoiling the molten metal.

The apparatus illustrated herewith is designed for installation at the mouth of the ash-pit or other suitable duct. It consists of a skeleton frame A, within which are hinged skeleton doors B, adapted to open and close from and to each other, and in which are fitted a series of vertical louvres, pivotally mounted in bearings, the louvres on each door being coupled by short links to an actuating bar, provided with a handle; in effect the apparatus is, in fact, a glorified venetian blind. All the joints are asbestos padded, so that when closed it is practically air-tight. When it is desired to regulate the supply of air to the ash-pit, the bar F is moved aside, whereby the louvres D are turned upon their axes, thus forming ducts for the air to pass through. As the louvres are arranged vertically, they do not interfere with the operations of cleaning the grate. The doors can be opened for the removal of ashes, as also to afford the maximum amount of air when required. A simple catch is provided to lock the actuating handles in the desired position. We understand that this system is now in use at a large foundry in the Midlands, and is giving very satisfactory results.



View showing one door closed and one open, with louvres open.

GRAZEBROOK'S AIR CONTROLLER FOR MELTING FURNACES.

"Drawbacks" in Hand Moulding.

By Walter J. May.

Where a pattern will lift clear of the mould, everything is straight sailing for the moulder, and even where there are projections on a pattern it may very well occur that by splitting the pattern and having a flask with more than two parts good lifts may be secured; but as this usually means the casting of special flask parts, the cost becomes too great for individual jobs. Obviously, certain castings have to be

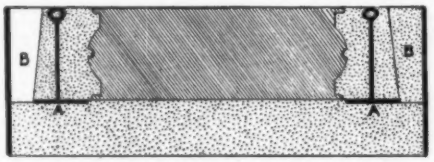


FIG. 1.

moulded by hand to enable work to be done which it is not possible to do on a moulding machine, and as these usually form isolated jobs, clearly they make it necessary for the moulder to get over the difficulties in the best manner he can.

Generally speaking, there is not sufficient attention paid to making patterns convenient to the moulders;

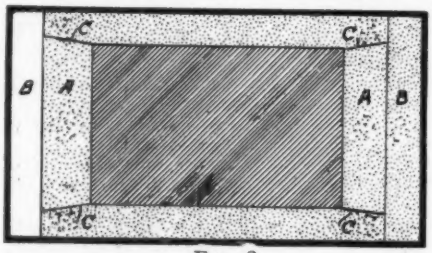


FIG. 2.

and, although this may bring out a man's skill and resourcefulness, it does not tend either to speed or cheapness in producing castings. This leads to a good many rough-and-ready makeshifts having to be improvised, and where there is a lot of makeshift work to be done most moulders have hoards of unconsidered trifles stored away against eventualities. Very use-

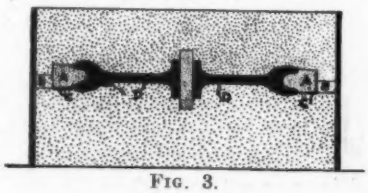


FIG. 3.

ful, no doubt, these things are as makeshifts, but it would really pay better to have properly-made things fit for the use intended, as then they could belong to the shops as a whole, provided they were in sufficient numbers.

A "drawback"—other names are used in various places—is a part of a mould which, after being rammed up, is drawn back from the pattern to permit of its removal, and then put into position again and made good for casting. Generally, they are made up on iron plates, with or without lifting rods, and the general idea is shown in section in Fig. 1, this representing a pattern which would be dealt with in a different manner in most cases, but is sufficient for the present purposes. Taking this as an example only, the whole side would be rammed up with the plate A in position, as shown, and then the back part of the sand would be cut away, as shown at B, and after rapping the pattern, the sand drawback on the plate would be worked back, clear of the pattern,

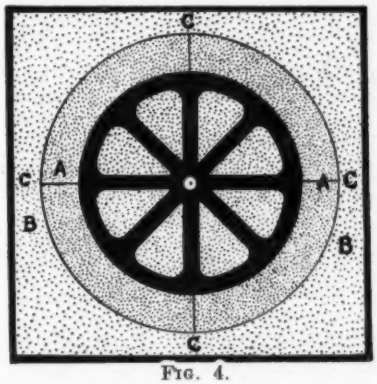


FIG. 4.

and the pattern lifted in the usual way, the drawback then being again worked forward and the space B rammed up. To ensure a clean parting at the sides it is well to use a piece of paper (waxed or oiled, as used by grocers, for preference) at the sides of the drawback, as shown in Fig. 2, this preventing the breaking away of the sand where the joint occurs. Necessarily the exact form of drawback must depend on the pattern, but so far as ordinary vertical

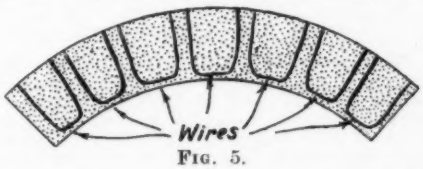


FIG. 5.

work is concerned, this explanation is sufficient to show the principle of the work, the manipulative skill having to be acquired in actual practical working.

There is, however, a different use for this kind of work very handy where repair jobs are a special feature of a jobbing foundry, and which makes the moulding of grooved wheels and similar things a comparatively easy matter when working with old castings as patterns, an example being that of a grooved pulley of moderate size. Cores are not always readily made for work of this kind, but with drawbacks properly made there is little trouble, as the green sand will hold well enough for casting thin

work if a little care is taken and a few wires are bedded in for stiffening purposes. A vertical section is shown in Fig. 3, a grooved wheel being taken as a sufficient example of the work, A A being the drawbacks on plates, B B the sand to be removed temporarily, C C pieces of paper under the plates, and D the pattern. Three sections of drawback plate would be necessary as a half circle would not draw cleanly, and the paper should surround the whole pattern in the position shown, as the plates would not reach to within half an inch of the pattern. The arrangement of parts is shown in plan in Fig. 4, the reference letters being the same as in Fig. 3. In making the drawback portion of such a mould as that shown, it will be found that some support is needed for the overhanging sand which forms the groove in the wheel when cast, and for this purpose stout wires of at least an eighth of an inch in diameter should be used, say, from 10 B.W.G., to 8 B.W.G., and these should be arranged as in Fig. 5, the object being to secure not only strength, but also stability. Paper should be used to divide the sections of the drawback, and when replaced in its original position the sand should not require mending.

The sand should be worked up as tough as possible for this class of work because if too friable it is liable to drop more or less during moulding, while in addition the flow and pressure of the molten metal would probably cause breakage and erosion to some extent.

Some care is necessary in venting such parts of moulds as are partly surrounded with metal, and this particularly applies to the class of work which has been described, because there is the obstruction caused by the plates to be taken into consideration. If the metal touches the plates air pockets may be formed under them, and in addition there is the chance of chilling parts of the casting, but if the plates are kept ½ in. back from the mould and the paper parting is used as described, there can be no question of chills occurring, but of course the air and gases must be allowed free escape below both paper and plates.

It is always necessary to rap the patterns to free them from the sand before withdrawing the drawbacks, and it is desirable that they should come back as levelly as possible to prevent deformation, a little care and what can only be described as "gumption" being necessary in dealing with work of this kind.

Price of Vanadium.

While the price of vanadium (about 10s. per lb.) is high, having regard to quotations for other alloys used by steel makers, the chief thing to be considered, the International Vanadium Company points out, is not so much the price per pound, as the additional cost imposed by reason of the use of the metal. In the case of vanadium, the action is so potent that a small proportion insures the desired results, and indeed any admixture of quantities approximating to those used of such other cheaper metals as tungsten, chromium, or nickel, would produce a steel probably unfit for use. Taking vanadium at the present price (to which it has fallen from a figure of about 25s. ruling three years ago), the cost of producing vanadium forging or spring steel is appreciably less than that of 3 per cent. nickel steel for the same purposes, even allowing for the value of the nickel-steel scrap. The view that the use of vanadium is limited is somewhat erroneous, the opinion being advanced that over 75 per cent. of the better known high-speed tool steels now manufactured in Sheffield contain vanadium as an ingredient. The International Vanadium Company also believes that the nature of the occurrence of vanadium is such that there is no reason to believe that the cost of the metal will be reduced for some time to come.

Points for Young Moulders.

The face of a mould should always be softer than the part behind it.

Whenever hard ramming is required, it should be done on the outside portion of a mould.

A rammer should never be allowed to strike a pattern when ramming up a mould.

When ramming up the sides of a pattern, the peen should not go nearer than 1 in. to the face; the butt should be kept 1½ in. from the face.

Too great a depth of sand in a ramming is apt to cause swells upon the sides of the casting.

In ramming courses of sand, the rammer should be made to feel the under or last course rammed.

Too much ventilating will seldom do any harm, but hard ramming will.

Hard ramming requires good venting.

To vent hard ramming requires muscle; do not be afraid to employ it.

Learn to ram evenly and lightly.

Some moulders will ram harder than others, so that moulds differ in density.

He who practices hard ramming for every job will always have the most trouble.

Some parts of a mould require and will stand harder ramming than others.

The higher the head or pressure upon the lowest portion of a mould, the harder should be the ramming there.

Plain vertical sides of a mould will stand harder ramming than the flat bed-surface of a mould.

Cores, or a projection that is surrounded by iron, should be rammed even and lightly, and also be well vented.

Any bottom section of a mould that is covered rapidly with iron, so as to have a pressure upon it, will stand harder ramming than where it is to be covered over slowly.

The lowest point of a mould's sides is the one which should be rammed the hardest.

The highest point of a mould's side is the one which requires to be rammed the lightest.

The flat surfaces of copes or top parts will stand harder ramming than the bottom surfaces of the mould.

One inch thickness of facing sand over a mould will peel a casting as well as 12 inches.

The use of facing sand has caused more bad castings than common sand.

Using the facing sand too strong causes cold shut, or streaked castings.

Do not use facing-sand 1 to 8, when 1 to 10 would peel the casting.

Facing-sand will stand the wash, or running of iron, better than common sand, where gates or runners are cut.

The first course of ramming in a cope should be evenly and firmly done; the second and third courses do not require such careful ramming as the first.

The flat rammer is used to make the sand solid between the bars, so as to keep it from dropping out.

In using the flat rammer care should be taken not to pound the cross bars, as that is apt to loosen the sand on the face of the bars.

Always be sure that the bars of the flask are solid and fixed in so as not to get loose.

When the top part is on, try if it will twist in the pinholes; a casting made in a mould that has not been carefully closed looks bad.

See that all cores used are the right size and that all the vents are clear in them, before placing them in the mould.

Be sure that you pack all grains or chaplets.

Commencing a Small Iron Foundry.*

By E. Henderson.

Any moulder who desires to start a small foundry requires, besides a thorough, intelligent grip of the practical side of the trade, a knowledge of the commercial aspect also. If he has not this (and under existing conditions moulders have very little opportunity of gaining any commercial knowledge), he should associate himself with, or secure the assistance of someone who has. Also, anyone thinking of commencing the business who has not some practical knowledge should use the utmost caution. There are many pitfalls in founding into which those not initiated may very easily fall.

At the commencement there ought to be a very definite plan of business. The iron foundry has a very wide range, and the writer would suggest that it is best to confine attention to one class of work if possible. There is a great future for specialisation in the supply of single articles for various trades, such as cylinders, propellers, condensers, bed-plates, or even fire-bars, for marine and similar work. A foundry specialising in the supply of single articles in this way if established on right lines and well equipped would be much more profitable than the present all-round establishments. There is also the jobbing foundry, for which there will always be a place, and it is the commencing in a small way in this class of foundry with which the writer particularly wishes to deal. It is important to thoroughly understand that the business exists to meet the customers' requirements and convenience. The time is past when engineers would take anything from the foundry so long as it was a casting; they are becoming more and more exacting, and the foundry must strive continually to raise the standard of its work. The founder must also be strictly upright in all his transactions, keep faith, and no matter what it may cost must never in any circumstances cover up a vital defect in a casting. The location of the foundry will be governed by the customers' convenience, and the possibility of delivering the goods conveniently and economically, and also by ready access to its own supplies. Heavy carriage or cartage for supplies coming in or goods despatched will be a serious handicap in a business which at the best has a rather meagre margin of profit.

Organisation.

Organisation is a matter of great importance, and may easily be the factor that will make or mar a business. Ideal organisation will take human nature fully into consideration in finding out what particular work each worker likes and is best fitted for, and will place them under conditions as far as ever possible conducive to good health and mental and physical fitness. Consideration of the health and fitness of his employés will repay an employer in any business.

An expert should be at the head of each department. It is not generally necessary to have a staff of experts that is costly, but there should be one at the head of each department with an interested, ambitious understudy who can be trained to take the place of the one above him when required. Hands trained in one's own works are generally much better than newcomers, and it is good for the one below to know that if he will qualify he will be pushed on as soon as there is an opening for him.

*Abstract of Paper presented before the Newcastle and District Branch of the British Foundrymens' Association.

The cost of labour is generally the heaviest cost in the foundry, and great care must be exercised to keep it down to a reasonable minimum, but it is not sound economy to employ inefficient labour because it is cheap, for in the foundry perhaps sooner than any other trade the fallacy of such a policy will be demonstrated in the form of rough and unsightly castings and a large waster pile. On the other hand, it is very wasteful to pay high-priced labour to do work which less skilled hands can do equally well. A proper proportion of skilled and less skilled labour should be in each department. The various departments must be equally balanced. The core-making and cleaning department must be proportioned to the moulding-floor requirements and output, all departments being carefully adjusted to each other.

Piecework.

Personally, the writer believes that all round better results are obtained by the piece-work system than by any other system. It is a just system, the man with the most ability getting his worth, and the others in ratio. It is also economical, and the hands require a minimum of supervision. Then, above over all, and whatever system is adopted, is the very important matter of "atmosphere," *i.e.*, the feeling existing between the employer and employés, and between the employés themselves. This will be governed most largely by the head of the firm. Whatever example he shows, whatever character he displays will be reproduced throughout the establishment.

The Site.

The location of the business has already been touched upon. The site itself should be carefully chosen on ground at a reasonable rental and with security of tenure. It is seldom satisfactory to rent a building and adapt it to a foundry's requirements. It is far more economical to put up a new place exactly to the requirements. Here the man of small capital will meet a grave problem, but the writer would strongly urge that a new place be put up rather than a good deal of money be spent in adapting some place which when it has been made the most of, will probably be little better than a makeshift.

If one does not feel justified in going to the cost of a brick building, corrugated sheet iron can be used, in which case care should be taken to have the iron thoroughly coated with a good protective material over the galvanising before being put up, as the steam and gases in the foundry very severely attack the iron. But if a strong gauge, say No. 18, be used and be well protected, it should last about 10 years. All girders should be of steel. A small building will only be required at first, say 1,000 ft. in area. Further extension should be kept in mind, the building being put up so that an end can be taken out and extension made without interfering with the work, and with a minimum of trouble. In a shop 40 ft by 50 ft., five to eight tons of light work can be turned out, casting three times a week.

A useful type of building is one with a centre bay with lean-to on one or on both sides. The centre bay, for making the heavier work, will require the installation of the crane; the lean-to will be used for hand-work. The building should be as high as possible, and have ample ventilation. The old-fashioned roof swing shutter ventilator is difficult

to beat for the foundry. Ample overhead light is essential to good and economical working. Men can do more work and do it better with plenty of light. For artificial light some form of incandescent gas light will be found best.

As far as possible means should be taken to have the shop warm and dry in winter, airy and cool in summer. The writer would also like to see a dressing-room in every foundry, so that the men can come to work with decent clothes and change them or put on overalls on starting or leaving work; and a lavatory with wash-basins for use before leaving the place, and a comfortable dining-room provided with some good literature for the use of those bringing their meals to their work. This will probably be somewhat advanced for the man starting in a small way, but it is good to have a clear ideal and press toward it. The charge upon the capital to supply these items mentioned would not be a heavy matter to any works of considerable size.

The Cupola.

The next thing to be considered is the cupola, which will be best placed at the end of the shop nearest the railway or nearest the stocks of iron and coke. It is not necessary to go to the comparatively heavy cost of a patent furnace of any kind; a good stout old ship's funnel will make a good shell for a cupola. It ought to be of $\frac{1}{4}$ in. to $\frac{3}{8}$ in. plate, and a little larger in diameter that will be required at the first, say, 3 ft. 6 in. to 4 ft. It is easy to line up to any internal diameter required and afterwards, when business increases, to build back to the shell. The lining should be 9 in. up to the charging door; afterwards $4\frac{1}{2}$ in. will be sufficient. The writer is not convinced of any distinct advantage to be gained from special shapes in cupola linings.

The funnel mentioned will require holes for breast and charging doors, and holes for the tuyeres in suitable positions. It is not necessory to go to great expense for a wind belt and two rows of tuyeres. Good results can be obtained by the old-fashioned two-tuyre furnace. Builders' smoke-pipes will make very good tuyres. They should be ample size. The writer is not convinced of the utility of narrowing the pipes to get blast pressure in the furnace. This appears rather a mistake, especially where a fan is used. Ordinary clay drain pipes will be found excellent for blast pipes from the fan to the bottom of the furnace, but if they are laid under a cart road or anywhere where loads or weights are to be taken over them they should be strengthened by having a few inches of concrete over them.

The cupola will then be plain, straight, solid-bottomed, 2 ft. internal diameter, with two 8-in. tuyres entering 2 ft. from the bottom, and with blast pipes from the fan 12 in. diameter. The fan should be 2 ft. diameter with a 9-in. outlet, and running at 3,000 revs. per min. The cupola will melt about two tons per hour, with a coke consumption 1 to 10, not including the bed. The charges would be 5 cwts. of pig and heavy machinery scrap, and would give good hot iron suitable for any thin castings $\frac{1}{4}$ in. thick, that have to be machined. The cupola will give 17 or 18 cwts. per tap.

Fan and Power.

The fan still holds a high place in the judgment of many good foundrymen, and as the first cost is considerably less than that of a blower, the beginner will probably decide in its favour. It should be borne in mind that for small work it is absolutely essential to have hot metal. Everything possible should be done to ensure this, for mistakes in this direction have to be paid for dearly. All that part of the plant which may be expected to last for several years should be put in with a view to future increased requirements.

The next item calling for attention is the power to be installed. Here there is a choice of three; steam, gas or electricity. Probably in the light of simplicity, reliability, economy and first cost the preference will fall on the gas engine. At the present there are almost any number of good second-hand gas engines to be obtained which would easily carry the beginner over the first five or ten years of his business. He could then decide whether a change was desirable or not.

Every foundry doing a good deal of small work should have a tumbling barrel and emery grinder. These should be of strong heavy type to stand the characteristic heavy usage of the foundry. A small mill and a machine riddle will be very valuable, but a little contrivance in connection with riddling apparatus and a judicious use of artificial binders will enable one to do without these until more capital is available.

Crane.

The foundry should be laid out and equipped to deal with castings at least up to two tons, since it is often from the heavy castings the foundry may expect to recoup for the small profit usually made on small work. Accordingly a crane will be required to handle cores and boxes, etc., and the writer would advise an overhead travelling crane of suitable strength.

Stove.

A suitable stove would be one 15 ft. long, 8 ft. wide and 8 ft. high, built of 9-in. brick with cast-iron girders across the roof, 2 ft. apart and $\frac{1}{2}$ in. thick, cast-iron plates between the girders, the whole covered with about 4 in. of concrete.

Two good-sized grate fires on the floor, one at each side of the stove, will be found sufficient to dry a stove full of cores. Two "H" section steel girders laid on cast-iron sleepers make a very convenient and handy bogey road. If the stove is too large at first, the doors may be placed inside the stove just leaving the space required for the fire chamber. The other part of the stove could then be utilised as core stores for stock cores, and cores not required at the moment. A cast-iron frame for core-grate bed should be put in the floor at some handy spot.

Moulding Boxes.

Many jobbing founders appear to greatly handicap themselves by adopting the bedding-in system of work. Work bedded in the floor costs more to make, is not so true to the pattern and the casting is not so sound; and although the rolling-over system may require considerable outlay in a good stock of boxes, it will amply repay itself in quicker and better work, and will also ensure a longer life of the pattern.

The moulding boxes should be made as strong and as light as practicable in regular standard sizes. The series may begin with a box 14 in. square with cast-iron pins, the next sizes being 18 in. square, 2 ft. square, and so on in 6-in. sizes up to 5 ft. square. Then there should be an oblong series beginning at 18 in. by 9 in., 2 ft. by 1 ft., 3 ft. by 18 in., 4 ft. by 2 ft., and so on, while a few boxes 5 ft. by 18 in., 7 ft. by 20 in., 9 ft. by 22 in. would be useful. The smaller sized boxes should be about $3\frac{1}{2}$ in. deep, and those from 2 ft. upwards should be 5 in. deep. It will not be necessary to make any of the sizes named more than 6 in. deep. They should be made tops,

drags and middles with box-bars so arranged to leave a good-sized square hole in the middle of the box to allow for cores and vents that have to be brought through the box. The middles should be made of "L" section, the bottom of the "L" being a stout internal flange around the box 1 in. square, to give it great additional strength and form a bearing on which cast-iron bars may be placed when required to hold up the mould.

Strong wrought-iron handles are indispensible in boxes of this kind, as a section of the mould 3 or 4 ft. deep may have to be lifted together, all the weight having to be carried by the handles on the bottom box. Larger boxes will be required than the sizes given, but the same system should be adopted throughout. It is never really necessary to make any size of box deeper than 6 in. Large boxes can be lifted by hand, which is a great consideration where there is no yard crane. This system also is better than boxes made in plates and bolted together. These are very clumsy. The handles are also used to cramp the mould together, by means of simple rectangular cast-iron loops made in a series of sizes to fit moulds requiring two, three, or any number of boxes, and slipped on the handles and secured with a cast-iron wedge.

For expeditious handling of moulding boxes no doubt the best system is a stout steel beam slung on the crane hook with notches beginning from the centre, 18 in. apart, to take the smallest boxes and then notched every 3 in. right along the beam to take the largest box; then a pair of shackles with a chain pulley and endless chains passing over the pulleys in each of them to move along the notches of the beam. This is an extremely handy and safe device where the work is rolled over. Four cast-iron pins cast on the sides of the smaller boxes will be found sufficient, but the boxes from 2 ft. up should have lugs cast on them to take suitable pins where there is a deep lift or a deep core in the mould. It greatly simplifies matters if only one size of pin is used in all boxes. Of course, boxes drilled to a template are best, but with a little care good fitting boxes can be made with holes cast in and a suitable cast-iron pin made to fit snugly in the holes. A simple system of foundry boxes like this will quickly be found to be far and away better than the inadaptable style of making special boxes for each job.

A Moulding Machine.

Some type of moulding machine to handle small work will be found useful. Custom requiring large quantities of small castings will generally be found willing to bear some part of the expense of having pattern plates fitted up.

The Foundry Floor.

No doubt the best way to get a floor in the foundry is to get used sand from another foundry's cleaning shop (many foundries would be glad to have someone to take a few loads away). This, when riddled and mixed with a little new loam and wetted with weak clay water will be found excellent floor sand.

Facings.

With regard to facings, it is much the best to have someone to mix all facing sand to ensure uniformity. Two kinds can be regularly mixed. One for the finer work up to ½ in. thick, another for work from ½ in. to 1 in. If sand is required for heavier work it is easy for the moulder to mix in a further quantity of coal dust to suit the job in hand. For castings requiring a smooth skin the coal dust should be very fine and the sand used as dry as possible.

With regard to the quantity of new sand required in the facings, there is undoubtedly a great deal of waste in many foundries. It is only necessary to replace the elements destroyed in casting to keep the facing up to the standard. In light work, say, from ¼ in. thickness up to 1 in., not more than 1/10th of new sand is required. It is often difficult to maintain a uniformly clean, smooth surface on the castings in jobbing work, where there is often considerable variation in the thicknesses of the casting, and also in the temperature of the iron. It is therefore good to have all moulds heavily coated with good plumbago, and carefully sleeked; this will put a good skin on the casting, independent of the quantity of coal dust, varying thicknesses, or casting temperature of the iron.

Loam for Swept Cores.

Where there is no mill, loam for swept cores can be made by mixing the sand and new loam as required with a little hair and chopping or cutting down with an iron by hand. A little core gum is beneficial. Sweeping loam to carry ¾ in. can also be made in this way.

Core Sands.

Core sands may be made with half rock sand, half sand from the foundry floor and a little core gum, about one handful to about one pail of sand. This will make a good strong core that will handle well.

Iron Mixtures.

The founder of small work will require iron that will run very fluid and not chill. For this the Middlesbrough district irons will be found very suitable for a basis, as they are rich in phosphorus and silicon. Professor Turner has stated that "the ideal method is for the founder to have a fairly large stock, including several kinds of iron, each separate kind being a little too hard or a little too soft for the general run of work, but still not very different from what is required. By using these irons in suitable proportions it is then easy to obtain any composition that may be desired, it being, of course, assumed that the composition of each variety is already known." It will not be convenient for the small man to carry large stocks, nor is it necessary, especially if he confines his attention to one class of work; but the principle put forth by Professor Turner is good for a foundry doing small work.

The writer recommends the No. 1 pig, which is a little too soft, with good machinery scrap, which, when re-melted, is a little too hard. It is then simply a matter of getting the proper proportion of each to give the iron desired. A good working mixture would be:—1½ Middlesbrough No. 1; ½ Scotch No. 3 soft; 1½ foundry returns; and 1½ machinery scrap.

No 1 irons carry a good percentage of scrap, so that while costing a little more than No. 3 the mixture will work out about the same in cost. This gives the advantage of being able to vary the mixtures to a greater extent than is possible by using No. 3 iron only.

For an odd job requiring specially soft iron, a little powdered ferro-silicon can be put into the ladle. For work required to stand considerable water or steam pressure, a ¼ or ½ of No. 8 iron added to the charge in the furnace will close up the grain. If extra strength is required the percentage of Scotch iron can be increased.

Cost.

The cost and working capital of a foundry set out on the lines indicated would be somewhat as follows :—

Iron building, 40ft. by 40ft., including erection and lining of cupola, putting down fan and gas pipes	200
Small overhead travelling crane with blocks, chains, etc.	30
Cupola, fan, gas engine 8½ B.H.P. with blast pipes and staging	50
Five tons of moulding boxes..	25
Weighing machine and small tools	15
Sundries	15
Three months' supply of iron	190
Three months' coke, furnace and stove	20
Three months' sand, blacking and coal dust	15
Three months' sundries	25
Three months' wages	230
Three months' general expenses, rent, etc...	35
Total	£850

This may seem rather small, but the writer has known a foundry with a considerably larger output than the above, running with less capital.

A year's balance-sheet might show somewhat as follows :—

Dr.	£	s.	d.	Cr.	£	s.	d.
To Capital	850	0	0	By Building, machinery, etc., £335, less depreciation, £20	315	0	0
,, Wages, salaries ..	920	0	0	,, Working capital	535	0	0
,, Iron	600	0	0	,, Sale of castings	1,952	0	0
,, Coke	88	0	0				
,, Cartage	30	0	0				
,, Rent, rates, etc. ..	60	0	0				
,, Oil, firewood, etc.	9	0	0				
,, Stationery.. ..	10	0	0				
,, Repairs	10	0	0				
,, Small tools ..	30	0	0				
,, Sand, coal dust, etc.	60	0	0				
,, Sundries	30	0	0				
,, Depreciation ..	20	0	0				
,, Balance	85	0	0				
	£2,802	0	0		£2,802	0	0

The Paper concluded with extracts from the FOUNDRY TRADES JOURNAL of April, 1904, regarding a number of points to be observed in running a foundry.

Discussion.

The CHAIRMAN (Mr. Edward Smith) said that the introduction of a dressing-room into a foundry was very ideal, but he did not think it was likely to be successful.

MR. PAULIN said he could only look at the subject from an engineer's point of view. There was one remark of Mr. Henderson's, however, which he could speak on, namely, that on no account should foundrymen cover up vital defects in a casting. The difficulty was that the foundryman rarely had sufficient frankness to disclose the defect before it was covered up, and it frequently reached the engineers' shop and got to an advanced state of machining before it was discovered, thereby wasting much time. After that it was rejected as faulty. The question resolved itself into who was the best judge as to vital defects. Generally speaking, the engineer was, because he knew what stress was brought to bear on it, and it must be admitted that foundrymen generally did not equip themselves with that knowledge of applied mechanics which would help them considerably to form a true estimate as to whether a defect was vital or not. He thought Mr. Henderson was covering rather a big area when he referred to experts being placed at the head of each department; one could hardly expect a small foundry could be divided into so many departments as to have experts in each except perhaps the owner of the foundry himself. He quite agreed with Mr. Henderson as to the amount of glass in the roof, but thought one might go a little further and say it would be much better if the glass was put on that side of the roof which got the sun in the morning. He had found that men always worked better after dinner if the sun was not shining on them. With regard to boxes being supplied with wrought-iron handles, after all it was not the handle that always broke, whether wrought-iron or not, but more frequently the portion of the box in the vicinity of the handle snapped through constant contraction stresses and those bending stresses which were so fatal to a flat face on which there was a lever (the handle) projecting with a chain attached to it; that gave a very awkward stress to the side of the box, and very often cracked it at an awkward moment.

MR. SMITH said he did not exactly agree with Mr. Henderson when he said that hands trained in the foundry were the most suitable men to take charge; it was possible to keep a man too long. He thought a stranger coming into a foundry to take charge had, as a rule, more authority over the men than one who had worked amongst them for years, and thus become familiar with them. He quite agreed that the piecework system was the best in the foundry. Mr. Henderson had mentioned that blast pipes should be laid sufficiently far down so that a cart would not injure them; that meant underground. The cost of blowers and fans was doubtful. He found he could put in a blower cheaper than a fan to get the same pressure, but it depended on the quantity of air and other factors. He would say, as regards the crane, put in an electric crane at once, as that was the most economical thing to be had now. If one did that, to carry out Mr. Henderson's suggestion of using gas would mean that both gas and electricity would have to be installed, which would not be very economical. With regard to the boxes he would say, buy no boxes in starting until it was found what sized boxes were required, and as otherwise there might be a stock of useless sizes lying idle.

MR. HENDERSON, replying to the various criticisms, said that every foundryman acknowledged the need for raising the status of the foundry as a trade, and he thought the dining and dressing rooms formed a step in the right direction. His remarks regarding the covering up of defects were to call for more resolute dealing; they had better lose £20 than lose a customer. How could the foundryman get the engineer's standpoint and see things from his point of view? With regard to boxes, he took it that the foundrymen would make their own boxes, and had put these down at £5 each. Reverting to the question of defects in castings, Mr. Henderson said that Mr. Paulin, as an engineer, was most kind to the foundrymen. When thing passed out of the foundry that were not altogether up to the mark, they generally found engineers down on them at once. Mr. Paulin, however, had excused the foundryman, and said, "He does not know."

A hearty vote of thanks was passed to Mr. Henderson for his Paper.

A New White Alloy.

A somewhat unique white metal alloy containing a large amount of iron has been patented by Mr. J. F. Duke, of Manchester. The proportions are as follows :—Iron, 50.30 per cent.; nickel, 19.16 per cent.; copper, 29.14 per cent.; aluminium, 1.40 per cent. It is claimed by the patentee that the mixture is quite non-corrosive and white, and in spite of the large iron content, it resists the action of vegetable acids and the atmosphere exceedingly well. If a further hardness is desired, from 1 to 2 per cent. of tin is added.

Making and Moulding of the Screw Propeller.

By D. GORDON.

Propellers are invariably made in one of two ways, either moulding from a single-blade pattern, or striking up in loam. The former method is employed for propellers up to about 3 ft. diameter, and the latter for those of 3 ft. diameter and upwards. At the moment the pattern-blade method only will be dealt with.

The pattern is made by "building up" in overlapping strips, the amount of overlap depending upon the pitch and diameter. Only one blade is necessary, and is placed, when moulding, into position according to the number of blades required in the finished propeller.

It is necessary, before starting to build up the pattern, to thoroughly understand what is meant by "pitch," as this latter is most important in the working out, or developing, of the blade.

The pitch of a propeller is measured in exactly the same way as that of an ordinary screw thread, and is the distance it will travel forward in one complete revolution. If a cylinder of paper (Fig. 1) be formed and a line be drawn round it to represent an ordinary screw thread, then the distance the line has advanced in one revolution is the pitch. If the cylinder be unwrapped and laid out flat, it will be found that the line which represented the screw thread is a straight line (Fig. 2). The angle this line makes with the circumferential edge of the paper is known as the angle of the screw, or in the case of a propeller, the pitch angle.

When the pitch is variable, that is when the line on the cylinder (Fig. 1) does not travel forward in an axial direction equal distances for equal distances travelled in a circumferential direction, then the line is not straight but curved, and the angle will vary with the pitch.

To find the angle of the blade of a propeller at any particular point, a distance equal to the pitch should be set out along a line, and along another at right angles to it, the circumference of the propeller at the particular point for which the angle is wanted should also be set out; then the free ends of these lines on being joined will give the angle required. This follows from Fig. 3, and it will be noticed that the angle of a uniform-pitch propeller increases as the boss is approached, as obviously the pitch is the same at any diameter, but the circumference decreases.

As an example for making the pattern blade may be taken the three-bladed propeller shown in the drawing Fig. 4, the diameter of which is 1 ft. and the pitch 1 ft. 6 in. (uniform). In starting, a number of strips are cut out, as shown in Fig. 5. If these strips are ¼ in. thick and there are 72 of them piled one on top of the other, the height of the pile will be equal to the pitch of the propeller, *i.e.*, 1 ft. 6 in. If a circle 1 ft. diameter be taken and divided into 72 equal parts, one of these parts will be the amount each strip has to be set back upon the one underneath it so as to make one complete revolution with the 72 strips. There will then be formed one complete revolution of a screw whose diameter and pitch are 1 ft. and 1 ft. 6 in. respectively, and are the same as the propeller. The amount of "set back" can be obtained by calculation instead of actually dividing the circle, thus:—The circumference equals 12 in. by 3.14 in., and this, divided by 72, gives 0.52 (½ in.). This is the amount of set back at the radius of the propeller, or the outer edge of the strips (Fig. 5). As a finished blade does not consist of a complete revolution but only a portion (usually ⅛ in. of circumference is sufficient for the width of blade), only ⅛ of the number of strips are required, which in the present case will be 12. Care must be taken to allow plenty of backing in the width of strips for the thickness of blade, but the definite thickness may be cut back at various positions for working up the back (Fig. 5), and such definite thicknesses are arrived at from the section view (Fig. 4). The strips are glued and pinned together, wooden pins being used, and driven in as near the angle as possible. Screws for holding the strips together during the building-up process and whilst the glue is setting, are an advantage, provision being made for them by an excess backing as at A (Fig. 5). The face of the blade is cut by joining the lines of the "set back" with chisel and gouge, working the boss to shape by template, letting it run into the face of the blade by a clean-cut fillet. On this finished face the shape of the blade is then drawn and cut. The back is then finished off to shape, working from cut-back to cut-back of each strip, and then working longitudinally one to the other. The alternative method of doing the back is to make a template to the various sections (Fig. 4), fitting these latter to their various positions and then working radially, running one into the other, as for the first method.

Another method commonly adopted for building up is by the use of a pitch plate (Fig. 6), which obviates the necessity of marking off the "set back" on each strip. It consists of a piece of tin cut to the pitch angle and bent to the radius of the propeller, it being kept to shape by a piece of wood cut to the same radius and nailed to it. On the "setting" or laying-out board the propeller diameter is drawn, and the pitch plate fixed, the radius of the pitch plate being the same as the radius of the propeller. A hole is drilled in the board at the propeller centre, this being to receive a wooden pin or plug, very often the size of the print, and the overlapping strips will have corresponding holes to fit on the pin. The strips are made as in the first instance and placed over the pin, the pitch plate fixing the "set back" (Fig. 7). It is then proceeded with as in the first example.

Propellers are made both right and left handed, and in building up care should be taken that the overlapping strips are right and left hand respectively. In the pitch-plate method the plate must be either left or right handed, as the case may be. The propeller edge next the ship cuts down into the water and is known as the leading edge, the other edge being the following or after edge. The surface of blade which propels the ship forward is called the face, and the other (next ship) is known as the back, or drag, surface.

In moulding the propeller from a single blade in green sand, boxes are invariably used, the floor being very rarely used as a bed. With reference to the boxes, care should be taken that the pins are well fitted and "easy" in the sockets, as in this class of work a great deal of lifting is required, with the obvious necessity of well-fitting pins. The bottom box is rammed up, joint upwards, to within 2 in. of the joint with black sand, and levelled to the joint with good facing sand. In the centre of the box a peg is driven, a portion of it projecting above the joint, and its diameter corresponding with the hole

* Brief lecture before the London Branch of the British Foundrymen's Associations.

cut on the propeller boss. In some practice a print is fixed to the boss, and this is utilised as the pivot, but this method is not satisfactory, and is very liable to create great inaccuracies owing to the "give" of the sand around the print.

The blade is placed over the peg and revolved into the surface of the sand, making a bed the shape of which corresponds with the propeller edge. This bed is then slightly "sleeked" over and an ordinary metal pin is driven through the edge of the blade

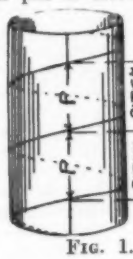


FIG. 1.

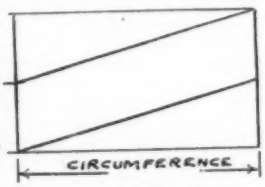


FIG. 2.

and allowed to project sufficiently to mark a circle on the sleeked bed. The blade is then removed and this circle divided up into the number of blades required on the finished propeller. When these positions have been ascertained, by compass or trammels, they are made permanent by bedding into the sand small pieces of tinplate, which project from the surface so that the edge of the blade will come into contact with them; they thus form a good stop for placing the blade in its required positions.

The blade having been placed over the peg, and against one of the tinplate stops for the first position, the underside of the blade is backed up to the top edge and given a good slope. Against the boss, which is very often barrel-shaped, a joint down to the centre must be cut away. The backing is sleeked over and vented downwards. The boss which is in contact with the top side of blade has now to be made up to the required joint, and to release the pattern for withdrawing purposes it is necessary to give a slight screwing motion.

Having now moulded the underside of the blade with convenient boss joints, parting is dusted over the whole and a top box placed over. This box is filled and rammed, using good facing sand against top side of pattern, and ordinary black sand for filling the box to its entire depth. The sand in contact

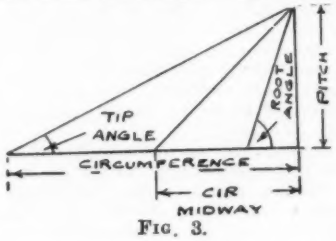


FIG. 3.

with the pattern and its underside make-up is thoroughly vented and the top box is then lifted off. The weak portions of sand, more especially that which has to take the screw for withdrawing, must be well sprigged and fixed, after which the pattern is withdrawn. Having now completed the mould for one blade, the pattern is placed in its second position

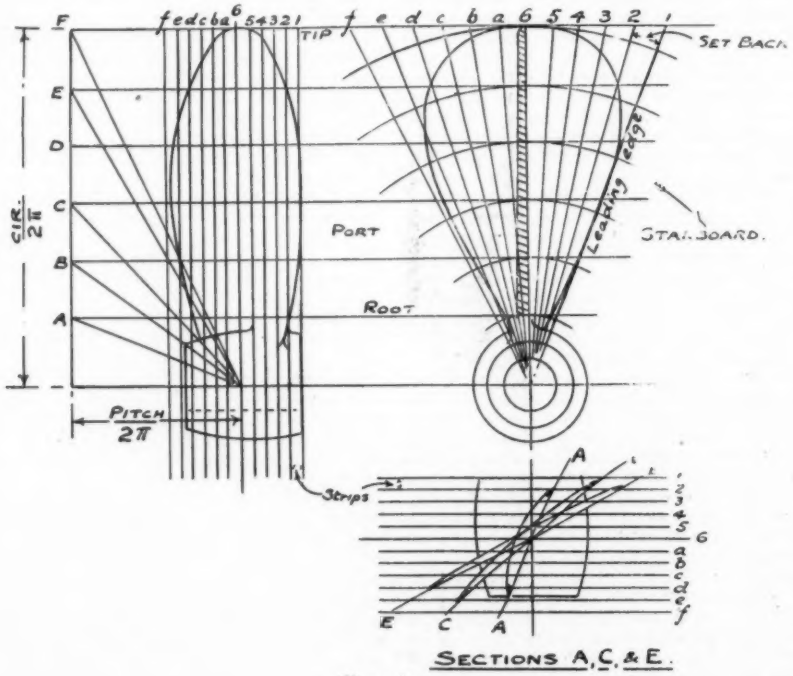


FIG. 4.

and a similar process of backing up, as for the first blade, is followed out, with the exception that the boss joints in this case must run into the joint already moulded by the boss in contact with the upper surface. The method for the second upper surface joint is the same as that for the first position. A hole is next carefully cut out in the top box sufficiently large

to clear the blade when returned. After parting sand has been dusted on the new joint, this box is again returned to position and rammed up, care being exercised against that portion joining the already moulded blade.

After venting, the top is removed and now contains the moulded upper surface of two blades. The pattern in bottom box is screwed out, and after weak edges have been firmly fixed, it is placed in the third position and the same process again gone through for the other blades required.

The cut-out for the last blade requires careful judgment, otherwise a crush and often a drop-out

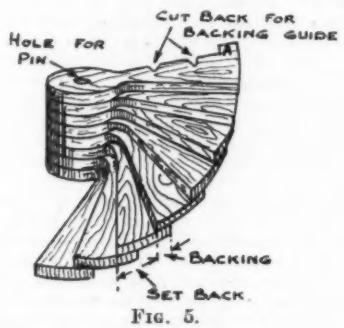


FIG. 5.

FIG. 6.

will ensue, causing both loss of time and temper. It is also when moulding this last blade that the runner stick is fixed in the mould generally at the top of the boss. A fairly large basin is attached to runner and acts at the same time as a good "head."

Discussion.

In the course of the discussion that followed, MR. WORRALL remarked that the method of moulding propellor blades described by Mr. Gordon was most interesting from the pattern-makers' point of view.

MR. SLATER described a method of moulding the propellor in a 3-part box, one part for each blade.

In answer to the discussion and questions, MR. GORDON said that one important feature of the method was its accuracy. He considered that all propellors over 3 ft. 6 in. diameter should be struck up.

Oil Fuel in the Foundry.

BY J. STONE.

The following notes on oil-fired furnaces are from personal experience, though that experience is somewhat limited, as the furnaces in question are not in general use. There is, however, a great future for oil as a fuel for foundry use. In its application there are eight important points to be considered, which may be enumerated as follows:—(1) The melting can be conducted in any atmosphere, as the metal is well protected. (2) The metal can be enclosed by means of a top pot and cover in such a way that the impurities in the fuel have no chance of affecting it. (3) The loss of metal is reduced to a minimum, through being enclosed. (4) The rapid heating is very beneficial in several ways, one being that the quicker the metal is melted the better; the lining and also the crucible, will stand a greater number of heats. (5) Any range of temperature can be obtained, up to a steel-melting heat. (6) The burners used are very easy to work, and those now being used by the writer (of the Höveller type) give a very even flare. (7) There is very little noise with these furnaces, and one man can attend to several at the same time, as there is not the laborious work which is associated wth the old coke-fired furnaces in clearing up, or, as it is sometimes termed, "firing off." In practice they can run when once charged until the end of the melt, as when once started they requre no further attention. (Of course this depends a great deal on the method of charging the crucible, as there are several ways of charging or filling a crucible furnace.) (8) Any kind of liquid fuel can be used for these furnaces, provided the proper burner is used. Crude petroleum is now being used by the writer.

There are a few labour-saving points that may be mentioned in connection with the oil furnace. There is no carriage of coke, which with some firms is a big item; there is no ash-pit to be cleaned out, which not only affords saving of labour, but also gives cleanliness to the shop, and this feature should recommend the furnaces in question to brass foundries; and the space formerly taken up for extra ash-pit and coke can be utilised for moulding, storage, or other purposes.

The cost (one of the first points of importance in modern production) of running, for a period of one hour, one furnace containing three crucibles, each holding 150 lbs. of metal, is at the present time about 1s., or at the rate of four gallons per hour, and the total time taken for the melt is 2¼ hours, or 2s. 3d. per 450 lbs.

The cost of the coke-fired crucible furnace for the same quantity of metal (melting in, say, a single-pot fire, which would involve three coke pits as against one containing three pots), would be 3 cwt. coke, at, say, 1s. 3d., or 3s. 9d. per 450 lbs.; this is with ordinary brass or gun-metal. Of course these figures are from our own working.

The writer's experience with these furnaces also extends to malleable cast iron, and in this connection

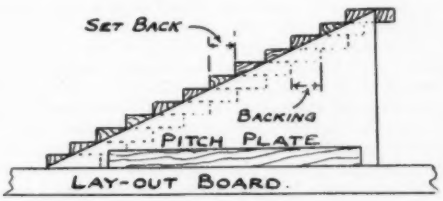


FIG. 7.

it must be stated that the malleable iron melted in these furnaces is much better than in the old coke-fired furnaces. The number of heats from the crucibles is very little less; we used to get 11 and 12 malleable iron heats from the coke fires with two pots in one fire, while at the present time we can get nine to 10 heats; but, of course, one must remember that the coke fires were natural draft and the oil fires are forced draft. The writer has had as many as six heats out of one furnace, two pots in furnace, or 12 pots with a total running time of 8 hours 40 mins., the time being taken from the starting of the furnace to the finish of the melt, not counting the time for charging the pots, as during that time the fuel would not be consumed. The best thing the writer can say about the preservation of the crucible is that as soon as the metal has been poured it is better to put the pots back into the furnace as quickly as possible, so as to avoid the

* Brief Paper presented before the London Branch of the British Foundrymen's Association.

scaling of them. It is very important that they should not be allowed to scale. Regarding the quality of the metal, the writer tested two pieces; the oil-furnace piece bent well, while the piece from the coke fire bent not so well.

Discussion.

In the course of the discussion, MR. J. ELLIS raised the objections against the use of oil-firing, of the cost of the fuel and the effect on the crucibles.

MR. BARTLETT desired to know whether there was not a very unpleasant smell accompanying the oil combustion, to which MR. STONE replied: "Not if the furnace is properly worked."

MR. WORRALL remarked that with the furnace under discussion, in the event of a pot breaking the metal would drop into the bottom and be saved, whereas with the coke furnace it would be largely wasted.

Other discussion followed, in which it was elicited that the wide range of fuels which could be used, including tars if suitably atomised, would probably give a great future field to the oil-fired furnace. In reply to the discussion, MR. STONE gave some further interesting figures regarding the economy of the oil-fired furnace, according to his experience.

Charging Different Mixtures in the Cupola.

One of the most difficult problems in foundry working and the one in which the writer has witnessed most failures, is the getting of several mixtures of metal from the cupola during the one blowing, *i.e.*, mixtures of cast iron with entirely different chemical constituents, and with entirely different fractures. For example may be cited a mixture of iron for work which has to be chilled, such as rolls or car wheels, with a very low silicon content, say, about 0.75 to 1.2 per cent., and phosphorus about 0.2 to 0.4 per cent., and giving a very mottled fracture; a mixture of iron for cylinders, containing about 1.25 to 1.6 per cent. silicon, and 0.3 to 0.5 per cent. phosphorus, and a very close fracture, but not mottled; and also a mixture containing about 10 per cent. of steel, which will greatly reduce the silicon and close the grain of the metal. Or perhaps some light castings may have to be made, requiring a very soft iron, rather high in silicon, and the fracture appearing very open.

The difficulty of keeping these different mixtures separate and of being sure that none of the one has melted much quicker than the other, and run down into a previous charge, is one of the most troublesome that the foundryman has to contend with.

From the writer's experience it is most essential that the most important mixture be melted first. But this rule cannot be followed always, as there must be taken into consideration which of the mixtures melts more readily than the other; possibly that may have to be taken first, so that it shall be clear of the mixture following. The hardest mixture, or, generally speaking, the lowest silicon irons being the easiest melted, should, in my opinion, be taken first, and between each mixture sufficient coke be put to keep the next mixture from coming down to the melting zone until the previous one has melted and is ready to be tapped into the ladle. Also the ladle must be carefully measured, so that when the desired amount has has been got out, that is to say, the first mixture, the blast can be eased, so that the melting of the second mixture is slightly checked, and it does not run down into the preceding mixture.

This operation should be repeated for each mixture to be melted, of course, seeing that the charges are placed in the furnace exactly as ordered. With the mixtures mentioned, the writer would take that for the chilled rolls first, the steel mixture second, the cylinder mixture third, and the soft mixture fourth. The reason for doing this is that the chilling mixture must be perfect, as anything getting into it would spoil the chilling effect, and it being a hard mixture, it will melt more readily. Also, if it followed any other mixture it might run down into it and harden it, and therefore spoil the castings to be made with the previous mixture. The steel mixture would be next charged as steel melts very readily with cast iron, and it is not desirable to get steel into the cylinder mixture, which would be the next charged, and care would be always taken to see that the metal is tapped in the right quantity, and that the layer of coke is sufficient to keep the mixtures apart. Following this would come the soft mixture, as this being the slowest to melt, would not be likely to run down into the preceding mixture.

Discussion.

In the discussion which followed, MR. BATCH questioned whether it was good policy to melt the hard iron before the best iron. He thought there would be less trouble with dirt if the best were melted first.

MR. BARTLETT replied that for chilled work his mixture would not be a dirty one; it would be one of the cleanest in the cupola—not a mixture of rough white iron and fire-bar scrap, as that was no good for chilled work. A rough mixture, of course, would be dirty, and should be charged last of all. For such a charge he would blow down up again in the same furnace.

An Analysis of Accidents in a Machine Tool Works.*

BY L. D. BURLINGAME.

A careful record of all accidents in the works of the Brown & Sharpe Manufacturing Company has been kept during the last seven years and a study made of them for the purpose of ascertaining where danger is greatest, what accidents are preventable and how best to avoid them.

An analysis of all accidents which occurred during the previous six years was made along three lines:—(*a*) The percentage of accidents under each of 18 headings from different causes; (*b*) the percentage by departments of the shop, divided into more than 30 groups; (*c*) the seriousness of the injury and the resulting length of disability from work. Following this, a similar record is being kept each year showing (*d*) what kinds of accidents are increasing and what kinds are being decreased by the further safety methods being adopted, also which departments are reducing their accidents and which are growing worse.

The different kinds of accidents were classified as follows, and the percentages given are for the six years preceding the date of the investigation, *i.e.*, 1905 to 1910 inclusive:—

	Total accidents.	Per-centage.
Caught in machinery	78	7
Caught or struck by belt	23	2
Set screw or other projection	29	2.6
Falling on or striking workman	226	20.1
Workman falling or strain lifting	75	6.7
Machinery starting unexpectedly	8	0.7
Chain or rope slipping or breaking	10	1.0
Punch press, rolls, or shears	20	2
Cutters and metal saws	94	8.5
Handling work or chips—eyes	126	11.2
Woodworking machinery	47	4.2
Burns, including electricity	79	7.0
Cuts with sharp instruments	20	2
Jams and hammer blows	71	6.3
Caught in tool and work (not cutters)	176	15.7
Elevator	4	0.5
Fooling	13	1.2
Litter or dark places	15	1.3

* Read before the Providence Association of Mechanical Engineers U.S.A. (Affiliated with THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS).

These accidents naturally divide into two groups:—(1) Those caused by machinery either (*a*) by being caught in the gearing, belting or other parts of the machinery, or (*b*) by being injured by the cutter or other tool or caught between the tool and the work; (2) those caused by falling, jams, burns, cuts, etc. The first group includes, 42.7 per cent. of the accidents occurring during the six years, divided as follows: Group (*a*) 12.3 per cent.; group (*b*) 30.4 per cent. This leaves 57.3 per cent. as the proportion of accidents occurring under the second group.

From the above analysis it will be seen that if complete guards could be provided so that every accident due to being caught in gearing, on set screws, or anywhere in the mechanism of machinery would be avoided, this would at most only reduce the accidents 12.3 per cent. Several recent occurrences show the unexpected accidents which result from this cause.

A way of preventing accidents by being caught by set screws or other projections also coming under this division, is to insist on the wearing of short-sleeved jumpers, to avoid loose clothing, hanging neckties, etc. Seventeen of the accidents reported were due to being caught by the sleeve of the jumpers.

The accidents in group (*b*) are more frequent and more difficult to guard against. It is practically impossible in many cases to do guarding at the point of cutting, and if guarding is attempted it may introduce dangers greater than those sought to be avoided. It is, however, possible to insist that the fingers shall never be used to wipe off chips, etc., from a running cutter. Out of the 94 accidents from cutters reported, 30 were caused by being caught when wiping off chips with the fingers.

In the use of punch presses 20 accidents had occurred in the period investigated, so this was one of the first matters to be considered. The means adopted for guarding against these accidents were novel, so far as the author is aware, and have proved fully successful both in avoiding accidents and in preventing an appreciable increase in the cost of doing the work. A rule was made that the fingers and hands must never be put between the punch and die. Tweezers and pliers were furnished for handling the work, the points being shaped in some cases to suit particular jobs. The only accidents since have been to the points of the tweezers and pliers. Shutes have also been used to slide the work into position, a stick being used to remove it after the operation. For some work which it was thought could not be handled by the above means, a swinging fixture was designed so that the work could be put in place away from under the punch and then swung into position for the operation.

The 47 accidents from wood-working machinery were largely cuts from circular saws, but included eight where the block of wood was thrown back when slitting, two of the cases being fatal, the only fatal accidents in the works during this period. The men are now required to wear a heavily padded apron when using a slitting saw, and this has, it is believed, saved the lives of several workmen. The use of a "spreader" when properly installed helps to prevent such accidents by keeping the cut from closing in on the back of the saw.

Another prolific source of accidents which, while not serious, perhaps, are painful, is in being cut by revolving grinding wheels, especially when doing internal grinding and trying the plug in the hole without running the wheel back a sufficient distance. Twenty-eight of the accidents were from this cause. A shield has been designed which automatically swings up in front of the wheel so as to protect the hand if the plug should slip.

Under the second group, falling, jams, burns, cuts, etc., a large proportion of the accidents are entirely within the control of the workman, either the one hurt or a fellow workman, and the remedy is largely to be found in employing careful methods. In this, however, the foreman can exercise a great influence for safety. Some specific remedies can also be applied. It was found that 37 cases of burned feet in the foundry had resulted from wearing laced or low shoes. A rule was made that "Congress shoes" or other boots without lacing should be worn, and a supply of such boots is kept and sold to the foundrymen at about cost price. This has nearly remedied the trouble. There remains, however, the liability of the iron spattering into the tops of the boots and burning the legs when the trousers are ragged.

About one-fourth of all the accidents are caused by weights falling on the workman and jamming or cutting either the hands or the feet, and from the workman himself slipping and falling. The remedy here is to be careful that safe methods are employed and that men do not take risks. Classified with these are 13 accidents traceable to "fooling," some occurring outside of working hours.

In considering the classification by departments and kinds of work, it was found that, for the period of six years, the average number of accidents was greatest in the following departments, the percentage of employés injured each year being as follows:—

(*a*) *Grinding department*, 13.8 per cent. being caused largely by cuts from grinding wheels. This has been much reduced during the past year, so that this department now ranks eighth instead of first in order of accidents.

(*b*) *Labourers*, 10.6 per cent., largely from injury by falling objects, jams, strains in lifting and the workman falling.

(*c*) *Carpenters*, 10 per cent., a large proportion of the injuries being due to wood-working machinery.

(*d*) *Foundry*, 9.5 per cent., due mainly to burns, also to falls and falling objects.

Then follow the various machine departments from 7.6 per cent. down to 2.2 per cent., and ending with the inspection department, the offices and the drawing office with the percentage coming down to 0.

In the classification by seriousness of injury and length of disability of 1,124 accidents occurring during the period of six years covered, 382 resulted in no disability, that is, no absence from work. In 457 cases there was less than one week's absence from work. Of the remaining 285 cases, 132 resulted in between one and two weeks' absence; 74 in two to four weeks' absence; 51 in one to three months' absence; five in three to six months' absence; and five in over six months' absence; in addition, eight were hurt so as to cause the loss of an eye, a foot, or permanent injury, two dying from the effects of their injuries. Ten men left, and no record was kept of the duration of their disability.

In 1911, with an average of 4,050 employés, there were 243 accidents, or about 6 per cent. of the workmen were hurt sufficiently to report; this on a basis of reporting slight accidents as well as those of a more serious character. Some of the added measures for safety had been in operation during part of the year, so that the gain from 6½ per cent., the record of the previous year, to 6 per cent. for 1911, indicated a gain due to such further safeguarding. This gain was also shown in the reduced number of serious accidents included in last year's list. There were no fatal accidents, no loss of eye or limb, and more than 70 per cent. of the reported accidents resulted either in no disability or in less than one week's loss of time.

Industrial Education.

Discussion on a Paper by J. W. Horne, B.Sc., Assoc.Inst.C.E.

(*Continued from page* 177.)

Mr. H. Brierley (Brown-Firth Research Laboratory) thought Mr. Horne might have called his Paper, "Competent People, and How to Make Them." The rub in the whole thing was how to make them. They could all admire the excellent German machinist who visited Dr. Ripper, but very few of them would be disposed to take a course of Schiller or Goethe in order that they might be competent factory foremen. (Laughter.) It never fell to his lot to be an apprentice of any sort, but if he had any choice in the matter—and there were very few people who really had an unlimited choice—he would like to have been an apprentice at Messrs. Ludwig, Löwe & Company, to have the general manager lecturing him in front of the rest of the students as to what was going through the shop. But English general managers did not seem to have been built of that sort of stuff. To be lectured on the jobs passing through the shop was one thing, but to be taught the duties of citizenship by the general manager was quite another thing. He did not know whether a workman wanted to be taught the duties of citizenship by his master, unless the master also gave the workman an opportunity of teaching him citizenship from the workman's point of view, because the point of view was not always necessarily the same. (Laughter.) He (Mr. Brearley) strongly objected to very strictly formulated systems of education. There seemed to his mind to be in the whole of modern education a tendency to force round pegs into square holes whether they would fit or not. Modern education, to his mind, was in many respects extremely inhuman, although in some respects very good. He doubted very much whether the standard of intelligence of boys was very much higher to-day than it used to be, although Mr. Horne seemed very well satisfied. To his mind, the best part of a boy's education was obtained neither at home nor at school, but was picked up anywhere and everywhere. There was one thing that Dr. Ripper pointed out that we had in the English nation, but he did not give a name to it. He (Mr. Brearley) would do so; it was resourcefulness, and there was no method of teaching children resourcefulness; the only means of developing that was by the provision of opportunities for its exercise, and those opportunities did not as a rule occur in the home or the school, but generally were to be found in overwhelming abundance in the street. He did not believe that the index of a man's value was the cost of his education. Where there were two men equally capable, he believed it was in inverse ratio; the man who was a good man and had very little money spent on his education had learned how to dig things out for himself, and generally the value of a man, whether he was a workman, foreman, or manager, was very highly enhanced if he had learned how to dig things out for himself. In addition to the school training or apprenticeship training, there must, to his mind, be a certain amount of advantage in the 6 o'clock in the morning training that some people had had to submit to. It was not nice, but according to their present system of carrying on industrial operations it did foster habits of body and mind which were of some value. It had been said—he would not like to say whether he agreed with it or not—that one thing which the school-trained man never learned how to appreciate was the value of hard work. There was also a saying that no work was too hard for somebody else to do. (Laughter.) There was another point to which he might refer, which gave an unmerited value to the student who had had the advantage of a trained apprenticeship and the technical school, and that was that he expressed himself very much better; he knew how in business to put the best side first.

Mr. W. H. Hatfield said that he was not in agreement with the lecturer upon a number of points. He agreed with Dr. Ripper that the English were quite equal to holding their own; they had done so in the past and were likely to continue to do so, and he (Mr. Hatfield) whilst not able quite to appreciate Mr. Brearley's contention, was of the opinion that the higher education of all the units was unnecessary. Industries in this country might, as the lecturer had said, grumble that they were not getting the right type of labour, but what was the good of grumbling. The major portion of the population constituted the industrial classes and therefore it was somewhat beside the point to talk about the "right type." He, Mr. Hatfield, claimed that perseverance, energy and a very good amount of brain power were the qualities which, coupled with traditional skill, had kept the nation going so far, and he believed would continue to do so. Mr. Horne in his lecture said he would not enter into economics. Unfortunately, however, economics were at the bottom of the whole discussion, and the lecturer had no right to discuss this subject unless he was prepared to take both economics and politics into consideration. He (Mr. Hatfield) said that he had men to control, and he had studied industrial education both from a commercial and economic standpoint, and as a graduate of Sheffield University he claimed to have gone through a training which was at present at the disposal of the population of to-day. He personally had worked for ten to twelve years at the rate of twelve hours a day, and he failed to see the lecturer's point altogether when he talked of making slaves of the boys who desired to work. The lecturer's system smacked too much of "molly-coddling." If there was ability it would find its way, and he heartily agreed with Mr. Brearley that if the education authorities would see that those boys who had brain and ability to occupy high spheres in life were given facility for cultivating their powers, that was all that was required. They all knew that in the works in Sheffield to-day they had young men who were occupying leading positions in the largest firms who were the product of the system of education which was receiving criticism. Mr. Horne commenced by talking about the lower strata; he (Mr. Hatfield) would very much like to discuss that phase, but he was afraid it would not do. The lower strata consisted mostly of relatively unskilled labour, whose main function was the output of physical labour. Any discussion on this phase was best done in camera. Dr. Ripper discussed American conditions, and the speaker said that he had also had the opportunity of studying these conditions, and whilst he could support what Dr. Ripper had said as to the facilities there offered for young men from eighteen to twenty-two years of age, he would also like to point out that alongside that estimable educational

facility were found a mass of labour of an intellectual grade in no sense superior to our own but which was driven at such a rate that the energy produced per unit on that side the Atlantic might safely be stated as 2½ times the energy on this side. An English employer who sought to decrease his cost of production by increasing the speed of his workpeople by 150 per cent. would, he feared, be likely to meet with considerable trouble; but this brought him back to the point that unless one was prepared to discuss economics, politics and philosophy, the subject were better left absolutely alone. At any rate he (Mr. Hatfield) did not think the subject one which should be discussed before a Foundrymen's Association. After all, every employer had to consider his conditions and environment, and he had to look after his own workmen, to educate them and to remunerate them, and the conditions which applied in one portion of the world would probably be unsuitable for another.

Mr. T. Swinden, supporting Mr. Horne's suggestion that whatever they could do as an Association to further the training of apprentices in the foundry they should do. The subject had been discussed by the joint Council and a committee had been formed to draw up a scheme. That committee had not got very far yet, but they hoped that something would be done to see if they, as an Association, could not do something to further the opportunities of foundry apprentices to get a better training. Professor Ripper mentioned that the great thing behind all success was the inherent quality of the individual. The two terms generally associated with this were heredity and environment, and there was no doubt that a great deal did depend upon them; but at the same time he would like to suggest to Mr. Hatfield that, as he well knew, there were men in the works who were thoroughly practical men at their particular job, who, had they had the training that he (Mr. Hatfield) or himself had had at the technical school, would have developed to the same extent and been quite as capable of doing similar work; the line of ignoring such people and saying that such a man was in the rank and file and must stop there was entirely wrong.

Mr. Swinden, continuing, said that if he was not trespassing upon a former address by Professor Ripper he would like to commend to their attention one phrase that entered his mind very strongly at the time; that was the great value of installing into the minds of workmen the student spirit. Unless a man had the interest of his work at heart, unless he took his everyday work as his life's interest, it must be a very poor life indeed. (Hear, hear.) One recognised in these schemes that Mr. Horne mentioned that the training was not to be purely utilitarian, it was to be general and to develop the student-spirit in things generally and to make a man a better trained all-round man, better able to absorb new ideas and to develop them to the benefit of his firm. The particular point had appealed to him as most interesting, and as most practical at the same time, was the system of State technical schools—a sort of higher education schools to which the students could be drafted from, say, the Council schools, to give them a little more specialised attention in the particular direction in which they were going to work. That was a grand idea which could be developed with great advantage. In regard to making foremen, everyone would admit that that was one of the greatest problems they had to contend with. Perhaps one point that should be added to some of the suggestions that had been made was that if all these facilities were to be offered to improve the value of foremen, and increase their general efficiency, some clause would have to be introduced to prevent that man going off to the manufacturer's next-door neighbour and carrying with him the secrets or the practice of that works. In discussing this question with many people there seemed to be a feeling that they were afraid of educating the rank and file. He could not see why that should be. There was, however, the feeling that they were trying to make everyone foremen and that there was likely to be discontent. The general education of workmen to-day was very much higher than it used to be, and it was also true that there was more discontent than there used to be, and perhaps there was some logic in the arguments that had been brought forward. But at the same time it was an undoubted fact that other nations were training their men and were getting better results in consequence, and he believed that when matters had settled down a little more both the better training of workmen and better conditions would come along side by side.

Mr. J. R. Hydes remarked that Mr. Horne was quite correct in regarding the sense of observation as the most important factor in the industrial work of to-day. Everyone of them who had tried to trace the history of a "waster" would realise the difficulty of ascertaining exactly what took place first; the power of observation was very much lacking. Consequently anything which tended to develop it was to be welcomed. He wondered whether it would not be possible to give a modified epitome, in very elementary form, of such science lectures as those of Dr. Ripper on the steam engine, to lads of 13 in the elementary schools. In addition to that, might it not be found possible to describe in elementary form, and briefly, the operations taking place in the Sheffield works. It would, he believed, open the eyes of the youngsters and develop an interest in the real work of later years.

Mr. L. Redmayne remarked that there was only one way of judging a system, and that was by its results. If a man made too many wasters he was "fired." It was a wonderful way of making them take notice, and certainly developed their sense of observation and resourcefulness as much as anything did. He did not know that it was any particular demonstration of his capabilities as a machinist that the foreman to whom Professor Ripper referred, was able to discuss English literature. Would that make him a better machinery foreman? As many of them knew, many of these gentlemen-apprentices were very clever men—so clever that they could do without work. (Laughter.)

Mr. Hatfield asked the lecturer: "Is it a fact that the higher developed the man, the less his desire and capacity for physical work?"

Mr. Horne, in replying to the discussion, said he realised just as much as the speakers the difficulties of the subject. In reply to Mr. Redmayne, he did not suggest that there could not be fools in a system such as he described; but with a definite system offering facilities for further education the inherent grit and quality of the Britisher would carry him further than grit alone. With regard to Mr. Hatfield's last question, he certainly said that if an individual were using his mental faculties to the full day in and day out he would not be fit to do a day's physical work. He admitted that at once; but in developing intelligence in order that an individual may be fitted to take an interest in and love his work, that effect on the mental faculties which would prevent him from doing a hard day's work was not produced. With regard to economics, when he remarked that he would not now discuss that aspect, it was on account of time, and for Mr. Hatfield's benefit he might mention that he hoped at the next Convention

of the British Foundrymen's Association to arrange for a Paper—not by himself, but by another gentleman—on the economic side and the relation of education to production; the fact of arranging that should show that he was not afraid of the economic side being discussed. With regard to Mr. Swinden's fear in regard to the training of foremen, if a national centralised system of industrial education was introduced, as he said it should be introduced into this country, then the foremen who were gaining all these benefits would seek to raise their position in life; but every industrial firm would have the same opportunities for profiting by this system of education, as was no doubt the case in Germany to-day, so that there would be nothing to fear provided the system were nationalised. He did not elaborate as he had intended to do the question of the improvement of the system of elementary education. There was no question that it was not perfect, and it could not become a perfect system, unfortunately, for as Mr. Brearley said, a hide-bound system of education in this country was not wanted. In Germany they standardised until they could standardise no further, and they realised trouble. The system of training teachers to-day was on the right lines; that was, they were being educated in secondary schools in which the classes were not allowed to be more than 25. The educational system was as far as possible perfect, for the reason that these teachers were being trained to think for themselves, and moreover, they were being educated in psychology and psychological methods, so that they would be able to study the trend of the children in their classes when they became teachers, and develop the mental faculties of the children in the same way as their own had been developed in the secondary school.

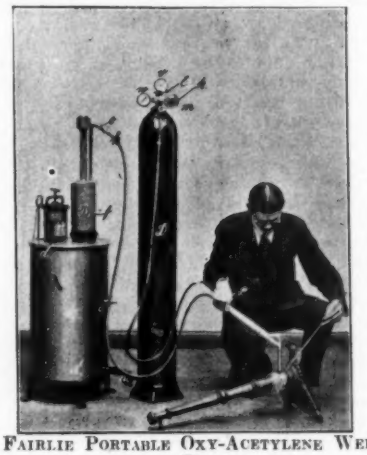
Concluding, Mr. Horne said he had gained his object if he had succeeded in bringing the matter to public attention, because the Board of Education would not do anything until the citizens of Great Britain realised that in order to keep the Empire in the position of being the greatest that had ever been, they must start with the children, and educate them in a way that would fit them for their life's work. Twenty millions of money was being spent to-day on elementary education, two-thirds of which was being mis-spent; and if the elementary education in the country was to come up to the standard that the citizens would desire to see, forty millions would have to be spent.

The PRESIDENT proposed, and PROFESSOR RIPPER seconded, a vote of thanks to the lecturer, which was heartily accorded, and in reply MR. HORNE said the discussion had convinced him that there was a real interest in the Foundrymen's Association in the subject of industrial education and a due realisation of its importance.

The Fairlie Portable Oxy-Acetylene Welding Plant.

The numerous applications of oxy-acetylene welding and cutting have rendered these plants valuable adjuncts to the engineering and metal-working shop. While the range of their application, however, is extremely wide, success is dependent to a very great extent on the proper regulation of the supplies of oxygen and acetylene to the burner. Any irregularity in the ratio of these two gases, resulting either from irregularity in the generation of the acetylene or improper control of the compressed oxygen, may spoil the results. For example, if an oxidising flame is used when cutting through a considerable thickness of metal, the cutting will not be clean or rapid, and may even fail. Or an excess of oxygen in welding will completely spoil the joint so far as strength and mechanical properties are concerned.

The Fairlie portable welding plant has been designed to avoid these troubles. This plant was recently inspected by our representative at the works of Messrs. Buck & Hickman, Limited, Whitechapel Road, London, E., who are the agents for the London area. It appears to efficiently embody automatic regulation of the gas supplies, and ready portability. The acetylene generator operates on the principle of the carbide, contained in a cage, being washed with water as required to generate a regular supply of gas, and any excess of supply at once stops further contact of carbide with water. A hydraulic safety valve is fitted to the generator to secure safety, and a waste tap is provided for removing the deposit. The acetylene, under regular pressure by reason of the operation of the generator, passes through an attached purifier to the blowpipe. The oxygen cylinder is fitted with a regulator which passes a predetermined quantity; on the needle of the regulator dial being set to the dial figure corresponding



THE FAIRLIE PORTABLE OXY-ACETYLENE WELDING PLANT.

to a particular size of blowpipe, the correct amount of oxygen is allowed to pass to the blowpipe, thus ensuring perfect combustion and the correct "cone" at the burner tip.

Some excellent examples of cutting and welding were witnessed by our representative, those on copper tubing calling for special comment as evidencing perfect regulation of the gas supplies and consequent absence of oxidisation in the welded part. The following table of capacities and working costs for the plant has been compiled by the makers:—

Blowpipe.	Approximate thickness of plate or joint.	Approximate consumption of acetylene per hour.	Approximate consumption of oxygen per hour.	Length of joint welded, per hour.
No.	Inches.	Pence.	Pence.	Feet.
1	1/32	¾d.	1d.	30—45
2	1/16—⅛	2d.	1½d.	24—36
3	⅛—¼	1¼d.	5d.	18—30
4	¼—⅜	2½d.	10½d.	12—18
5	⅜—½	5d.	1/9	9—12
6	½—¾	7½d.	2/7	6—11
7	¾—1	10½d.	3/9	4—6
8	1—1½	1/4	5/9	3—4

Some very satisfactory results were also obtained in the repairing of broken castings, building up of broken gear teeth, and similar work.

Correspondence.

Carbon in Cast Iron.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—In the discussion on Mr. W. B. Parker's Paper on "Specifications for Foundry Pig-iron," published in your March issue, Professor Turner, in referring to my Papers, states that he (Professor Turner) did not think anyone seriously intended that they should grade by silicon alone. My authority is the official proposal by America and Germany to England at the Copenhagen Congress of the International Association for Testing Materials in 1909.

Professor Turner's other remarks on my Papers are equally out of focus. He claims to have shown for the first time nine or ten years ago different sizes of graphite in different grades of iron. These differences were named by Percy, and published in his work in 1864, from the work of Berzelius prior to 1846.

My Papers have discussed the *character* of these carbons *in use in the foundry*, as explained in your leading article in the January number, in which you discussed "Steel in Cupola Mixtures."

In his reply to Professor Turner, Mr. Parker referred to a suggestion of allotropic forms of carbon in grading. He has unfortunately drawn in a private talk bearing on the *behaviour of these carbons in foundry practice*, not on grading by them.

Mr. Buchanan suggested the reason the Committee of the International Association for Testing Materials—upon which I had the pleasure of sitting—turned down the proposal of U.S.A. to grade by analysis was the conservatism of our blast-furnacemen. In this he is entirely mistaken. Blast-furnacemen would be quite willing to grade to reasonable analyses if satisfied that this would be more suitable than fracture. The Proceedings of the B.F.A.—to go no further—prove that analyses *pure and simple* cannot be relied upon to guarantee tests, or what is of much more consequence, solid castings: *vide* Cooke and Hailstone. Fracture *can* be relied on to get these results, if the user is able to read the fracture. My Papers give works' facts from my own works' experience to confirm my views.

The greater the maker's knowledge of pig-iron and the blast furnace, the less competent he feels to propose a simple and practicable form of grading for present needs. The late Lord Kelvin's name is connected with a simple illustration in regard to knowledge. Knowledge is represented by two circles, one small and the other large; the moral being that the greater our knowledge, represented by the areas of the two circles, the greater is the horizon of our ignorance, as shown by the greater circumference.

Yours, etc.,

E. ADAMSON.

Dore, near Sheffield,
March 18, 1913.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Regarding the Paper by Mr. Parker in your last issue, may I suggest that the whole subject would be much better comprehended by foundrymen if it were made clearer what the term "grade" means when used in this connection. We in the foundry use it to indicate the structure of the iron (as shown by its fracture); but Mr. Parker appears to use it to indicate the composition without regard to the fracture.

Also, regarding the irons given in Table I. of his Paper, particularly the close-grained iron with 3.74 per cent. of silicon and total carbon 2.82 per cent., are we to understand that all three would be either No. 1 or No. 1 Extra, and that the close and open irons would be equally suitable for the same work. The latter does not appear to be borne out in practice. It is, of course, quite conceivable that the cooling of the pigs would give the difference in the case mentioned: but when applied to two irons produced under different furnace conditions, is it not a fact that the grain of the iron, as shown by the fracture, has an influence, apart from the analysis. I shall be glad to receive correction on this point.

Yours, etc.,

London. "S. M."

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—I have read with extreme interest the Paper in your last issue by Mr. Parker on "Specifications for Foundry Pig-irons," and am inclined to agree that if the grading first refers to the fracture of the pig, and then demands that the composition be kept within the limits stated, we shall get close to a really workable system. But it is not clear to me whether the specification grade numbers given actually refer to the fracture at all. Indeed, it would appear otherwise from Mr. Parker's statement that "The true grading of a pig-iron is dependent upon its quantitive composition as regards combined carbon and silicon, and is not dependent upon the quantitive appearance of the graphite shown by fracture."

I will agree that the quantitive appearance of the graphite alone is no guide to grading, but practice has shown that the *fracture appearance* is a fair guide to the results to be expected when taken in conjunction with an approximate analyses of the metal, *i.e.*, the known approximate composition of a particular brand. After some considerable puzzling as to why this should be so, I came to the conclusion that the inherent properties of the different forms of graphite shown in the fractures were responsible: and this was upheld by the Papers on the subject which Mr. Adamson read before the Iron and and Steel Institute, which seemed to throw some light on the matter. But on reading Professor Turner's remarks in the discussion on Mr. Parker's Paper, I regret to find I have not been enlightened. The explanation which seemed to fit so nicely must go by the board, and it only remains to be discovered that those good castings, made by considering the influence of the graphite formation, are not good after all. Is it not rather distressing? We on the moulding floor are not in a position to contradict expert statements: we can only do our humble best to fit into practice the golden information which falls from high places, and then, when we think we have fitted in satisfactorily an explanation to some problem, we find it is not an explanation. Can it be that we must go on our way until the scientists have decided to agree, and in the meantime refuse all suggestions. And dare we hope that in the end it will be found that the practical man in his sublime ignorance has been in the right track after all.

Yours, etc.,

"MOLDEO."

Kent, March 10, 1913.

Fritz Laboratory.

It is reported from South Bethlehem (U.S.A.) that the late Mr. John Fritz has bequeathed £30,000 to Lehigh University, primarily as an endowment fund for the maintenance of the Engineering and Testing Laboratory, which Mr. Fritz gave to the University in 1910. This laboratory is one of the best-equipped of its kind in the world, and its construction and equipment were personally supervised by Mr. Fritz.

Inventions.

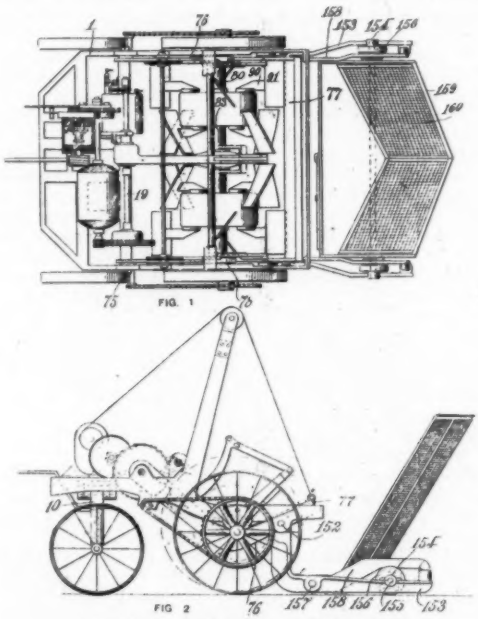
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

3,354. Cast-iron and process of producing same. R. Anderson.
3,409.*Sand blast apparatus. (Badische Maschinenfabrik und Eisengiesserei vorm. G. Sebold und Sebold & Neff, Germany).
3,554. Manufacturing cement steel. G. H. Benjamin.
3,753. Obtaining adhesive coatings of copper upon iron and steel. S. O. Cowper Coles.
3,754. Coating metallic articles with brass. S. O. Cowper-Coles.
3,755. Coating metallic articles with lead. S. O. Cowper-Coles.
3,874. Alloys of aluminium. T. A. Bayliss and B. G. Clark.
3,944.*Apparatus for pumping molten alloys at high temperatures and under heavy pressure. H. Debauge.
4,404.*Moulds for castings. Emil Seyer.
4,871. Grinding and sandpapering machines. G. H. Fellows, C. H. Fellows, and D. Darby, trading as Fellows & Darby.
4,888. Construction of gear-wheels. C. H. Brampton and R. H. Richmond.
4,908.*Crucible furnaces. (F. Hundt, Germany.)
5,068. Gas-purifiers. F. G. Brockway and H. Crossley.
5,069. Mills for grinding, crushing, sifting, separating, or mixing materials. Edgar Allen & Company, Limited, H. Grey, and L. D. Parker.
5,075. Moulding-machine for casting and moulding metals. J. Shepherd and H. Pettifer.
5,167. Moulding boxes. W. Ogden.
5,436. Liquid-fuel-heated tipping furnace for melting, smelting, refining and other like purposes, etc. S. W. Price.
5,452.*Smelting turnings and other cast-iron scrap. W. Wagner.
5,504. Treatment of iron or steel for the prevention of rust. T. W. Coslett.
5,570. Core-making machines. J. J. Chipchase.
5,639.*Pumping apparatus for molten substances. H. Debauge.
5,647. Valve for high-pressure gas tanks. W. M. Still & Sons, Limited, and E. H. Still.
5,725.*Apparatus for making moulds for pig-iron. H. Aumund.
5,813. Manufacture of iron and steel under direct processes. W. S. Simpson and H. Oviatt.

Abstracts of British Patent Specifications recently accepted.

14,711 (1912). *Sand-mixing Machines for Foundries.* C. F. Bowdle, 702, West Downing Street, Piqua, Ohio, U.S.A.; J. F. O'Brien 800, West High Street, Piqua, Ohio, U.S.A.; and F. L. Schmidlapp, Piqua, Ohio, U.S.A.—The object of the invention is to provide means for imparting to the sand-cutting members an accelerated movement when cutting the sand, and a subsequent retarded motion during which the sand is delivered from the cutting members, these movements being independent of the general rotary motion of the cutting members as a whole. Another object consists in providing means by which the accelerated and retarded movements may be made to take place earlier or later so as to vary the height of the resulting sand heap. Fig. 1 is a top plan view of the machine; Fig. 2 is a side elevation. The yoke 10 permits the sand heaps to pass under the forward portion of the machine, and as the machine travels forward, the sand at the rear end of the heap is engaged by a plurality of rotating shovels. Pivoted at 75 to the side members 1, are side members 76 of a frame which support the shovels, and which are connected by a bar 77 at their rear ends. The side members 76 are provided with bearings 78 which receive journals of outer sleeves 80. The outer sleeves 80 are provided with bearings which receive a shaft extending across the width of the machine. The outer sleeves 80 surround the shaft, and also surrounding the shaft are intermediate sleeves 83 similar to the sleeves 80. The sleeves 83 are provided with bearings, and are supported by the shaft. Keyed to the shaft are right and left spiders. The spiders support pins which extend from each side thereof. Mounted on the pins are rocking members, to which cylindrical members are attached by means of bolts. Extending from the cylindrical members are arms 90, to which shovels 91 are attached. The shovels 91 are placed in four series, one series on each side of each spider. The shovels are staggered, and are placed at an angle, so that when they are at the lowermost point the inner edges thereof will be toward the front of the machine. The shaft and the shovels carried thereby are rotated from the shaft 19, by a sprocket chain, which passes around a sprocket

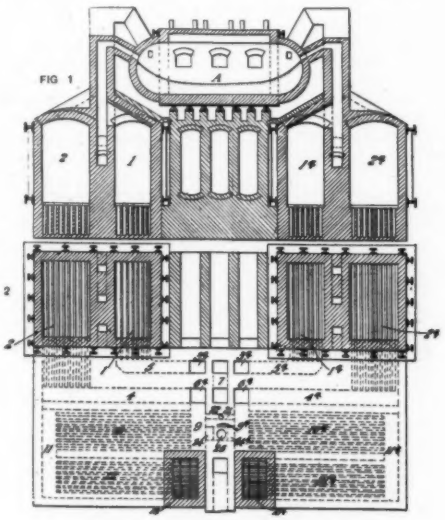


Sand-Mixing Machine for Foundries.

on the shaft and a sprocket on the shaft 19. When the shovels are rotated and are moved toward the uncut sand heap, they will cut the sand into small portions and will throw it to the rear of the machine, thereby disintegrating and reducing the sand to a pulverized, homogeneous mass. Owing to the inclination of the shovels, the uncut sand will be thrown towards the centre, thereby forming the uncut sand in a heap in the shape of a prism which occupies a minimum amount of floor space. To more effectually disintegrate the sand when it is thrown by the shovels, the shovels are given an accelerated and a retarded movement, during the period of their revolution, when they are throwing the sand. When it is desired to riddle the sand in addition to cutting it, a device is attached at the rear of the machine. The side members 1 of the main frame are provided with pins 152 which are united to the upper ends of L-shaped side members 153. These side members are provided with bearings 154, which receive a shaft 155 provided with wheels 156 which carry the frames 153. Pivoted to the frames 153 at 157 are rocking members 158, which support a frame 159 provided with a

screen 160. The sand is thrown through the screen 160 by the shovels 91, thereby effectually riddling the same. The screen is formed of right and left portions which are placed at an angle to effectually deposit the riddled sand in a prismatic heap.

16,041 (1911). *Reversible Regenerative Gas Furnaces.* A. Reynolds, Birkbeck Bank Chambers, Southampton Buildings, Chancery Lane, London.—Fig. 1 is a longitudinal section and Fig. 2 a horizontal section of reference. The usual gas regenerator chambers and air regenerator chambers are denoted by 1, 1^a and 2, 2^a respectively. From the bottoms of the gas chambers flues 5, 5^a lead to a reversing valve system 3, the seatings 3^a only of which are shown in Fig. 2 for the purpose of clearness. From the ordinary air regenerator chambers 2, 2^a flues 4, 4^a lead to a similar valve system 6 the seatings 6^a of which are shown in Fig. 2. These two valves are coupled so that they may be reversed simultaneously. The bottom outlets of these valves are connected by a short flue 7, and the valve 6 is provided with a cover lid 8, which precludes the entrance of air through the valve. The air regenerative system is extended through the flues 9, 9^a, to supplementary air economisers or regenerators of large capacity comprising chambers 10, 10^a, flues 11, 11^a and chambers 12, 13 and



Reversible Regenerative Gas Furnace.

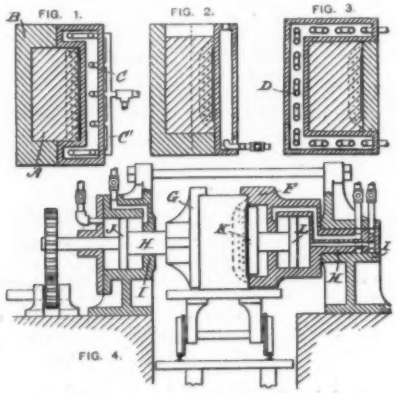
12^a, 13^a. Between the tops of the chambers 13, 13^a is a reversing valve or valves 14 by means of which and a forced draught fan 15 air is forced into one set of air chambers, while by means of a suction fan 16 the waste gases are drawn through the regenerative chambers and exhausted into a short chimney 17. When the furnace is working, air passes down through chamber 13 along chamber 12, flue 11, chamber 10, flue 9, valve 6, flue 4, chamber 2 and thence to the combustion chamber of the furnace A, while part of the waste gases passes downwards through chamber 2^a and traverses flues 4^a, 9^a and chambers 10^a, 12^a, 13^a and thence is discharged to the atmosphere at a low temperature by fan 16. The gas for the furnace is led from the gas flue 18 through the usual regulating valve 20 and a gas tube 19 to the reversing valve 3, and thence along flue 5 through chamber 1 to the furnace, while a portion of the waste gases descends through chamber 1^a, traversing flue 5^a, valve 3, flue 7, valve 6, flue 9^a, where it mixes with the rest of the waste gases from chamber 2^a, the whole of the waste gases traversing the course to the atmosphere already indicated. Any gas from gas tube 19 which may leak through reversing valve 3 will take the same course as these waste gases.

8,479 (1912). *Refining Process for Iron and Steel by Means of Ferro-Chrome Alloy.* J. Büchel, Wengern-Ruhr., Westfalia, Germany.—In using ordinary or commercial ferro-chromium for the purpose, carbides are formed in the steel which are admittedly objectionable. From extensive experiments carried out in alloying chromium with steel or iron, it has been found that it is highly advantageous to use ferro-chromium which is free from carbides and is so acted upon by reducing agents during the process as to be freed from oxides. It has already been proposed to use ferro-chromium which is free from carbon, or practically so, in the manufacture of steel, and it has already been proposed to use, in the manufacture of steel, ferro-chromium together with aluminium, silicon or an alloy thereof, the latter substances being employed for de-oxidation or other purifying purposes, but the present invention consists in the use of carbon-free ferro-chromium together with strongly-reducing agents, such as silicon and aluminium or alloy thereof in order to eliminate oxides from the ferro-chromium and prevent their passing into the steel or iron. Ferro-chromium free from oxide and carbide has a much lower melting point than ferro-chromium produced by the ordinary electro-metallurgical process. By introducing ferro-chromium in the way described an important condition is attained for the expeditious and uniform distribution of the chromium.

15,532 (1912). *Process for the Manufacture of Iron Alloys for Dynamo-Electric Purposes.* W. Rübel, 21, Esnen-Allee, Westend-Berlin, Germany. This invention consists in an improvement on Letters Patent No. 12,483 of 23rd May, 1911, in which an iron alloy for dynamo-electric purposes is described, consisting of iron technically free from silicon, phosphorus and manganese, with a certain percentage of copper, lead, silver or bismuth. It has, however, been found that the mere combining of the two processes does not produce a suitable raw material for manufacturing dynamo plates or sheets, if the hitherto customary procedure is adopted, because then the bath, after the removal of sulphur and phosphorus as well as of silicon, manganese and carbon is completely super-oxidised. By adding ferro-silicon or ferro-manganese the de-oxidation, and a certain recarburisation are effected. This adds a small amount, generally 0.3 to 0.4 per cent. of silicon and manganese to the iron. According to the present invention use is made of the de-oxidants calcium, strontium, barium, or magnesium. By means of these a complete de-oxidation can be obtained, and although residues of these metals remain in the copper-iron alloy nevertheless the alloy retains good electro-magnetic properties. The percentage of loss is even somewhat decreased when a small part of the de-oxidising metal remains in the bath. In order to attain the necessary effect it is sufficient to use the alkali metal (for instance, calcium) in quantities amounting to 4 per cent. of the copper, but even if the alkali metal is used in the same quantity as the copper no injurious effects would result. As copper must necessarily be added to the iron, the earthly alkalies or the magnesium are added in pieces in the form of copper alloys of the respective metals.

3,917 (1912). *Process for Forming a Copper Coating upon Articles of Carbon.* Gebr. Siemens & Company, 128 to 137, Herzbergstrasse, Lichtenberg, b/Berlin, Germany. The invention consists in a process for coating articles of carbon with metallic copper directly deposited on the exterior of the carbon article, in which the article to be coated is heated in a powder composed of an oxygen compound of copper. The carbon article to be coated with copper is embedded in a dry oxygen-compound of copper, and is then heated for about four to five hours. It is preferred to employ copper oxides, or copper ashes, for instance, copper scale. The final result is an extremely uniform, firmly adhering coating of copper of more or less thickness. The temperature employed may be, for instance, 300 to 400 degrees centigrade. The process is particularly useful in the coating of carbon brushes for electrical machinery.

16,093 (1912). *Method of Treating Metal Ingots.* G. H. Benjamin, 45, Broadway, New York, U.S.A.—Figures 1 and 2 are respectively horizontal and vertical sections of a mould provided with heating means; Figure 3 is a horizontal plan view of a mould provided with cooling means; Figure 4 is a vertical section of an apparatus in which an ingot may be subjected to lateral pressure along a portion of its length and rotated. In all of the figures an ingot is illustrated as in position. The molten metal A is poured into a mould B, so constructed that at least one side has a higher temperature than the other sides and bottom. This difference in temperature may be obtained by heating one side by heating apparatus C, C1, or by chilling three sides of the mould by a cooling apparatus D. By casting the ingot in a mould having one side of higher temperature than the other sides, one side of the ingot will re-

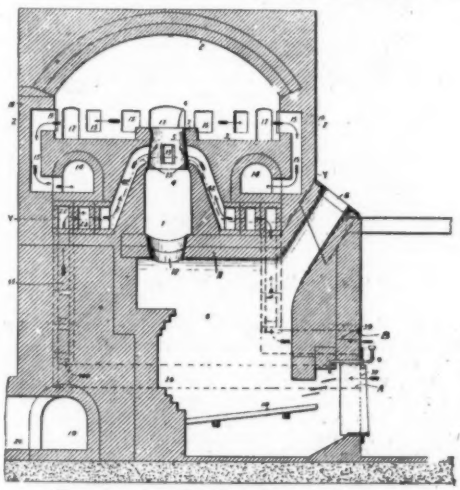


Apparatus for Treating Metal Ingots.

tain a higher temperature than the other sides and as shrinkage takes place in the cooling of the ingot, the soft metal upon the heated side of the ingot will accommodate for such shrinkage and the usual cupping or the formation of pipe will be prevented. After the ingot is cool enough to handle, it is lifted from the mould, placed upon a carriage and inserted between pressure plates F—G, mounted upon shafts H, carried in suitable bearings I. The plate G is made adjustable to and from the ingot through the instrumentality of a hydraulic piston J. The plate F is divided into two portions, one portion of which is fixed and the other portion K, made adjustable to and from the ingot A, by means of the hydraulic piston L. The purpose in using adjustable portion K of the plate F, is to provide means for compressing a portion of the soft side of the ingot, during the time shrinkage is taking place and the ingot cooling. Simultaneously with the exertion of pressure by the portion K of the plate F, the ingot is slowly rotated. The effect of the rotation is to overcome the tendency to segregation of the materials forming the ingot under the action of gravity, and this is aided by the lateral pressure along a portion of its length exerted through the portion K of the plate F.

3,752 (1912). *Treatment of Metals.* General Electric Company, of Schenectady, New York, U.S.A.—This invention relates to treating metals so as to protect them against the effects of oxidation. The inventors have found that iron, copper and similar metals when heated with aluminium powder to a suitable temperature and under suitable conditions arrive at such a condition that they may be heated to a high temperature for practically an indefinite period without any deleterious effect upon the metal. Under suitable conditions a protective alloy of copper and aluminium will be formed upon the surface of copper. This is accomplished by bringing aluminium powder into contact with the copper and heat to a proper temperature under conditions which prevent oxidation of the copper. One method is as follows:—The aluminium powder is thoroughly mixed with a certain percentage of sal ammoniac and zinc and the articles to be treated are placed in an oven and surrounded by the powder mixture. The oven is then completely closed and slowly rotated. A temperature of about 450 degrees C is maintained within the oven, and the treatment continues for about two hours. After the metal is taken out of the oven it is fired at a temperature of between 700 degrees and 800 degrees C. for about 15 or 20 minutes. One mixture which has been found to produce excellent results contains 70 per cent. aluminium, 24 per cent. sal ammoniac, and 7 per cent. zinc. A mixture of 60 per cent. aluminium, 30 per cent. graphite, and 10 per cent. sal ammoniac also produces very good results.

7,203 (1912). *Furnaces for Heating Copper Ingots, etc.* G. B. A. Gibbons, Dibdale Works, Lower Gornal, Stafford; and R. Masters, Gallant House, Dudley.—The annexed cut is a longitudinal sectional elevation of one form of heating furnace suitable for heating copper ingots, or for annealing iron castings, etc. The regenerative gas fired furnace is circular in plan, and the circular heating chamber has a domed top 2, and has in its floor 3 one central up-cast shaft 4, the upper part of which forms a combustion chamber 5. The up-cast shaft conveys the combustion gases from the usual gas producer 6. The centre of the heating chamber may have a low ring of brickwork 7 surrounding the gas up-cast shaft 4, so as to obtain a better delivery and distribution of the combusted gases. The gas producer may be of the well known kind with stoke-hole 8, water feed device 9 and grate 10, the arch 11 of the producer having an inverted conical or other passage 12 communicating with the up-cast shaft. Below the floor of the heating chamber there is an annular waste gas flue 14, into which outlet pasages 15 lead from the circular wall 16 of the heating chamber These pas sages are preferably arranged in pairs between the feeding holes 17 which pass through the circular wall. Leading downwardly from the annular waste gas flue there are outlet passages to the chimney flue 19, which has an outlet 20 leading to the stack. The secondary air is heated by passing through zigzag passages which



Furnace for Heating Copper Ingots.

are built in the side walls of the gas producer, and which by upwardly projecting ducts lead to the annular zigzag passages which are built in the furnace. Through these annular zigzag passages the secondary air passes up to and through the outlet nostrils 13, so that the gases are there combusted and pass from the open mouth of the shaft 4 over the goods on the floor of the furnace, the waste gases passing on through the waste gas outlets and passages 15 into the annular waste gas flue 14 so as to heat the secondary air passing through the regenerator, the waste gases then passing down from the annular flue 14 to the outlets 18 into the chimney flue 19.

Trade Talk.

THE Liverpool Chamber of Commerce propose forming an engineering section.

MESSRS. HODGKISS & WOODALL, brassfounders, have removed to Cox Street, Birmingham.

NEW offices are being erected in Paradise Street, Birmingham, for Stewarts & Lloyds, Limited.

MR. W. HOLMAN, coppersmith, Bowman Lane, Leeds, has removed to Great Wilson Street, Leeds.

THE BUTTERLEY COMPANY, LIMITED, have removed their London offices to 52, Queen Victoria Street, E.C.

MESSRS. G. HARLAND BOWDEN & COMPANY have removed to 1, Victoria Street, Westminster, London, S.W.

THE BLACKMAN EXPORT COMPANY, LIMITED, have removed to Blackman House, 374, Euston Road, London, N.W.

THE next general meeting of the American Iron and Steel Institute will be held in New York on May 23 and 24.

THE CARRON COMPANY, of Falkirk, have been granted a warrant of appointment as grate manufacturers to His Majesty.

THE MORGAN CRUCIBLE COMPANY, LIMITED, have established a branch of their business at Cambridge Street, Birmingham.

WITTY & WYATT, LIMITED, formerly of 88, Leadenhall Street, London, E.C., have removed to 38, Commercial Street, London, E.

C. F. CASELLA & COMPANY, LIMITED, scientific instrument makers, have removed to Gurney Street, Walworth, London, S.E.

THE works of Richard Garnett & Sons, Limited, engineers and ironfounders, at Leiston, Suffolk, have been partially destroyed by fire.

PETTERS, LIMITED, ironfounders and engineers, of the Nautilus Works, Reckleford, Yeovil, propose erecting additional works at Hendford.

THE BLAIR OPEN HEARTH FURNACE COMPANY, LIMITED, have removed from 20, Copthall Avenue, to Norfolk House, Norfolk Street, London, W.C.

MR. ED. BRAND, of 472, Moss Lane East, Manchester, has removed to London, and in future his address will be 96, Victoria Street, Westminster, S.W.

MESSRS. WILLIAM BAIRD & SON, of the Temple Iron Works, Anniesland, Glasgow, have been granted warrant to erect a new machine shop at their works.

THE UNIVERSAL GRINDING WHEEL COMPANY, LIMITED, of the Universal Works, Neepsend, Sheffield, propose erecting new works in Doxey Road, Sheffield.

MR. J. A. ANDERSON has severed his connection with the Electro-Flex Steel Company in order to open a business in Newcastle, specialising in the inspection of plant.

R. HOOD HAGGIE & SON, LIMITED, have removed their head offices to Akenside House, Newcastle-on-Tyne, where larger and more commodious premises have been secured.

THE premises of the Star Engineering Company, Limited, at Wolverhampton, have been seriously damaged by fire, several of the workshops being reduced to ruins.

AN interesting piece of work was recently carried out at the Broad Oaks Iron Works, Chesterfield, of Markham & Company, Limited, when a ram 38 tons in weight was successfully cast.

THE STEREOPHAGUS PUMP AND ENGINEERING COMPANY, LIMITED, have appointed John Birch & Company, Limited, of 2, London Wall Buildings, London, E.C., as their export agents.

MESSRS. M. EWING and P. KILPATRICK, carrying on business as engineers, at Crewkerne, Somerset, under the style of the Engineering and Foundry Company, have dissolved partnership.

MR. THOMAS BLACKBURN, proprietor of the business of Blackburn & Crawshaw, engineers, Paragon Works, Craven Street, Wakefield, has transferred the business to his son, Mr. L. Blackburn.

THE partnership heretofore subsisting between Messrs. S. Turner and C. B. Hogg, carrying on business as engineers, at 10, East Parade, Leeds, under the style of Turner, Hogg and Company, has been dissolved.

THE business of J. M. MacNeillie & Company, engineers and mill furnishers, 7, Bank Place, Kilmarnock, has been transferred by Mr. J. M. MacNeillie to Mr. T. Smith, engineer and mill furnisher, Fiona, Darvel.

MESSRS. A. S. DEWHURST AND J. TAYLOR, carrying on business as mechanical and electrical engineers, at Soho Works, South Street, Heywood, under the style of Dewhurst, Taylor & Company, have dissolved partnership.

THE creditors of the Ivorite Nickel Electro Foundry, Limited (in voluntary liquidation), are required to send particulars of their claims to H. H. Bobart, 22, Basinghall Street, E.C., the liquidator of the company, by April 28.

MESSRS. A. BLYDE & COMPANY, of the Wallace Steel Works, Sheffield, have again received the order from the county borough of Middlesbrough for the supply of their special "Crutch Brand" tool steel, cast steel, etc., for the ensuing twelve months.

AT a meeting of the shareholders of Muir & Houston, Limited, engineers, boilermakers and shipbuilders, Kinning Park, Glasgow, a resolution has been passed for the voluntary winding up of the company. Mr. J. A. Houston, 173, St. Vincent Street, Glasgow, has been appointed liquidator.

A SOMEWHAT serious fire has occurred at the Sphere Engineering Works of Engineering and Arc Lamps, Limited, St. Albans. The fire apparently originated at the south-east corner of the building, and three gables were completely burnt out for two-thirds the length of the works.

MR. R. H. JOHNSTON, London manager of the Rees Roturbo Company, Limited, Wolverhampton, and Mr. P. B. Down, of the same company, have established themselves in business under the style of Down & Johnston at Craven House, Kingsway, London, W.C., as engineers' agents.

THE shareholders of Molybdenite, Limited, have passed a resolution to the effect that it has been proved to the satisfaction of the company that the company cannot, by reason of its liabilities, continue its business, and that the company be wound up accordingly. Mr. Alfred Green, 52, New Broad Street, London, E.C., has been appointed the liquidator of the company.

HITHERTO the Heath Charnock Iron Works, Adlington, Lancs., have been devoted to the production of iron and brass castings for the trade, but the business has been recently converted into a limited liability company, under the style of Allen Barton & Company, Limited, to develop in other directions, more particularly in the design and construction of haulage engines, gears, etc.

THE GOLDSMITHS' COMPANY, who about three years ago, contributed £50,000 towards the extension of the Engineering Department in the Central Technical College, have now offered to pay the entire cost of the new building, amounting to about £37,000. In making this gift the Company stipulate that the portion of the capital belonging to the Imperial College of Science and Technology which will be set free shall be added to the endowment fund, the income being used for higher educational and research work.

AT a meeting of the shareholders of Mackinlay (Glasgow), Limited, metal merchants and refiners, 121, Great Wellington Street, Kinning Park, Glasgow, a resolution was passed to the effect that the company be wound up voluntarily. Mr. James Maclay Hood, 121, Great Wellington Street, Glasgow, was appointed liquidator. The liquidation is entirely voluntary, and solely for the purpose of reorganising the company. There will be no break in the continuity of the business, which will be carried on under the same management in every respect.

Sir John Randles, M.P., in opening the new Technical College and secondary schools at Workington, built and equipped by the Cumberland County Council at a cost of £30,000, said he desired to commemorate that occasion by a gift of £1,000 in Workington Iron and Steel Company preference shares to provide a travel scholarship, and to be awarded to a student of that Technical College. It would yield some £50 to £60 a year to the successful student for proficiency in the metallurgy of iron and steel in association with the local industry of that district.

A petition has been presented to the First Division of the Court of Session at Edinburgh by George Anderson & Company (1905), Limited, Taymouth Engineering Works, Carnoustie, praying their lordships to make an order confirming the reduction of capital resolved on by special resolution passed at a meeting of the shareholders. It is proposed that the capital of the company be reduced from £95,000 to £65,312 10s., divided into 47,500 preference shares of £1 each and 47,500 ordinary shares of 7s. 6d. each, and that such reduction be effected by cancelling the capital to the extent of 12s. 6d. per share on each of the ordinary shares.

Mr. J. C. Barns, metal founder, late of the Metal Works, Hill Street, Southwark, London, S.E., attended before Mr. Registrar Hope at the London Bankruptcy Court for his public examination, upon a statement of affairs showing liabilities £2,694 13s. 8d., of which £299 3s. 9d. were returned as expected to rank, and assets estimated to realise £254 17s. 11d. net. According to the debtor's deficiency account there was on December 31, 1911, a deficiency of £275, whilst the subsequent trading had involved him in a loss of £321. The depreciation of the premises was put down at £2,000. On the other side of the account, however, there was an item of £3,692 for goods received, in respect of which no claim was made. The debtor was subjected to an examination of considerable length, and the Registrar then ordered the examination to be concluded.

The annual dinner of the Sheffield Society of Engineers and Metallurgists has been held at the Royal Victoria Station Hotel, Sheffield, when there was a large gathering of members and friends, including Colonel H. K. Stephenson, Colonel H. Hughes, the Master Cutler (Mr. J. Rossiter Hoyle), Sir William Clegg, Sir J. E. Bingham, Bart., Mr. G. Blake Walker (ex-president of the Society), Mr. A. Balfour, Mr. Walter Dixon (president West of Scotland Iron and Steel Institute), Professor Kendall (Leeds University), Professor W. Ripper, Mr. W. F. Beardshaw, Mr. S. J. Robinson, Alderman Cattell, Mr. T. W. Ward (president of the Sheffield Chamber of Commerce), Mr. T. H. Firth (president of the Sheffield Branch of the British Foundrymen's Association), Alderman Wardley, Major W. Tozer, Mr. A. Senior, Mr. W. M. Gibbons, Mr. R. T. Wilson, Mr. Percy Longmuir, and others.

In view of the abrogation of the light castings agreement, and the attitude of the associated makers, whereby merchants consider themselves aggrieved, the Builders' Materials Central Committee, which, it is stated, includes the largest buyers in the country, is circularising the trade generally, the object being to form a directory of manufacturers outside the combine, showing the particular class of goods made by the various firms, and also what other classes might be made by each were sufficient inducement provided. Since, including the smaller foundries, there are about 2,000 makers of light castings in the kingdom, of which only a hundred are included in the Association, the committee apparently hope to be able to satisfy their requirements independently of it, and on more liberal terms. We understand that since the committee began to circularise the trade they have been approached by the Association, but meanwhile the work of forming the new directory proceeds, and makers who desire their names to appear in it should apply to Mr. P. Donald, honorary secretary of the committee, 113, Queen Victoria Street, London, E.C.

At the official opening of the British Westinghouse Club, at Trafford Park, Manchester, Sir William H. Bailey delivered an interesting address on "The Art of Seeing and the Art of Remembering, and their Possible Influence on Genius." In the course of his remarks, Sir William said he had known many of the old inventors of Lancashire, including Richard Roberts. He was the son of a poor shoemaker in Wales, and he became the inventor of the modern locomotive, the planing machine, the self-acting mule for spinning cotton, the paper-cutting machine, the carpet-weaving loom, and many other inventions. Probably he was the greatest mechanical inventor in all history, certainly the greatest mechanical inventor of the nineteenth century. He knew the literature of every subject that he engaged in, and the same might be said of Sir Joseph Whitworth; he received a better education than Roberts before he started business. Sir Henry Rawlinson, Past-President of the Institute of Civil Engineers, in a conversation with him (Sir William) some few years ago, said: "I am not a mathematician. I have been President of the Institute, but I was trained as a landscape gardener; then I had to do with the Lancashire and Yorkshire Railway Company, and became chief engineer of the Mersey Dock Board, and the bane of my life has been that my calculations of stresses and strengths have all had to be made for me." Yet this engineer was a great reader; he knew the literature of his subject, and mathematics were mere mechanical art. The free library was the working-man's university. The professor of a university really only told one of the books one must read to increase one's knowledge, so there was no very great difficulty in a man being his own professor. He had often found university men who had lamented their defective memories. He thought it was disgraceful for a man to admit it. Memory might be cultivated like any other physical quality, because it was physical; it was possible to improve the strength of one's muscles, and it was also possible for men to alter the shapes of their heads. A good education was much wasted if the memory was not cultivated.

SCALING APPARATUS FOR BOILERS.—An apparatus for keeping boiler plates free from scale has been introduced by the Pyro Boiler Cleaning Company, of 37-38, Essex Street, Strand, London, W.C. The apparatus is the invention of Mr. J. Schror, and consists essentially of an acetylene gas generator, a cylinder of compressed oxygen, a special double burner for an oxy-acetylene flame, and the necessary connections and flexible tubes for taking the burner into the interior of the boiler. The generator is of special design, of the carbide-to-water type, and is provided with a gas-cleaning or purifying apparatus attached, and also a safety device whereby any back-firing at the burner cannot travel to the generator and is thus rendered harmless. The generator operates at very low pressure —only a few ounces to the sq. in., or just sufficient to properly convey the gas through the pipes. The burner is of special construction, and is quite distinct in principle from the usual oxy-acetylene welding burner. The oxygen under pressure is forced through a fine hole and the acetylene passes through a series of large holes arranged annularly and capable of regulation. The mixed gases then pass into a divided channel to the two burners. When the resulting flame is applied to the scale on a boiler plate for a period varying from half a minute to a minute or two, according to the thickness of the deposit, the scale is disintegrated and falls away, assisted by steam pressure between the scale and the plate arising from the moisture in the scale being driven inwards through the heat of the flame. The simple application of the flame to the scale thus removes the latter quite readily, and, moreover, is effective with such slight deposits as are too thinn for chipping. Under some conditions the removal of the scale is assisted by a jet of water conducted through passages in the burner and impigned on to the scale after heating. It is important to note that the heat of the flame does not damage the plates, which are not raised considerably above the temperature which can be borne by the naked hand.

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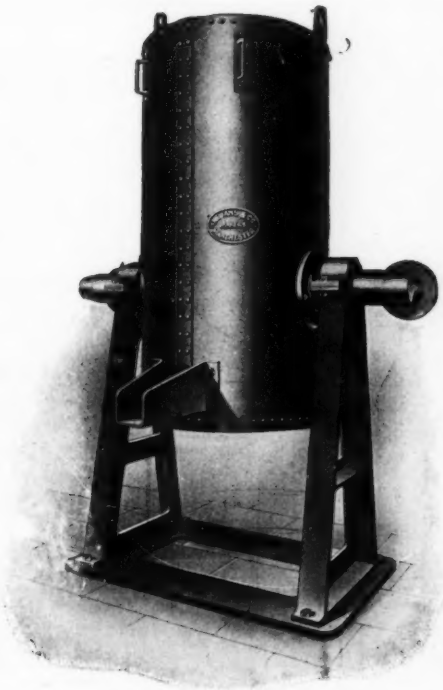

James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

Personal.

LIEUTENANT-COLONEL B. A. Firth has succeeded to the command of the Hallamshire rifles

MR. A. B. SCORER has been elected a director of Meldrums, Limited, Timperley, near Manchester.

MR. H. E. DEADMAN, C.B., a director of Cammell, Laird & Company, Limited, has resigned that position.

THE late Mr. J. Homan, of Messrs. Homan & Rodgers, structural steel makers, London and Manchester, left estate valued at £38,795 gross.

THE estate of the late Mr. Edward Manisty, M.I.C.E., for many years proprietor of the Dunkalk Ironworks, has been valued at £27,871 gross.

THE gross value of the estate of the late MR. J. J. Kimpton, of Messrs. Jas. Kimpton & Sons, ironfounders, of Limehouse, London, E., is £1,011.

THE will of the late Mr. J. W. Summers, J.P., M.P., of the firm of John Summers & Sons, Limited, Hawarden Bridge Iron Works, has been proved at £170,483.

MR. G. H. FAIRHURST, who has been in charge of the works of the Bengal Iron and Steel Company, Limited, for the past 16 months, has been appointed general manager.

MR. S. J. ROBINSON, managing director of Wm. Jessop & Sons, Limited, has consented to take over the command of No. 6 Company of the National Reserve (Sheffield Battalion).

MR. W. A. CARLYLE, professor of metallurgy at the Royal School of Mines, has decided to resign his position in June next to join Mr. J. F. Allan in a consulting practice in London.

THE late Mr. T. M. Lumsden, managing director of James Milne & Son, Limited, left personal estate in the United Kingdom valued at £1,241, in addition to which he owned real estate.

THE late Mr. B. J. Smith, late of Messrs. Wardrobe & Smith, Arley Steelworks, Sheffield, left estate of the gross value of £6,353, of which the net personalty has been sworn at £4,922.

MR. J. R. HALL, the secretary of the Carnforth Hematite Iron Company, Limited, who has been connected with the concern for the last 33 years, has been elected a director of the Company.

THE late Mr. Joseph Bramhall Ellison, one of the founders of Kayser, Ellison & Company, Limited, Carlisle Steelworks, Sheffield left estate valued at £78,147 gross, with net personalty £60,206.

DR. A. R. FORSYTH, formerly Sadlerian Professor of Pure Mathematics at Cambridge, has been appointed Chief Professor of Mathematics in the Imperial College of Science and Technology, South Kensington.

MR. W. C. ROBSON, secretary to the General Engine and Boiler Company, Limited, Hatcham Ironworks, New Cross, London, S.E., has been taken into partnership by Messrs. John Brierley & Sons, coppersmiths, Deptford Green, London, S.E.

MR. J. C. DAVIES, of Baldwins, Limited, and the Port Talbot Steel Company, Limited, has been the recipient of a presentation from the officials and men to commemorate his long connection with the company. He has also been elected a director of both companies.

MR. ALFRED SHUTTLEWORTH has been elected chairman of Clayton & Shuttleworth, Limited, in succession to the late Colonel Shuttleworth. The vacancy thus created on the board has been filled by the election of Mr. John Harris, who has been associated with the company for forty years, and is now the secretary.

MR. A. S. BIGGART has been elected chairman of Sir William Arrol & Company, Limited, Dalmarnock Ironworks, Glasgow, in succession to the late Sir William Arrol. Mr. Biggart has been associated with the company for many years, and for some time back has been joint managing director with Mr. John Hunter. Mr. Hunter is now sole managing director.

MR. W. HANNING, 17, Rue de Maubeuge, Paris, has been elected president of the British Chamber of Commerce in Paris. He is the agent in France for Thwaites Brothers, Limited, Smith & Coventry, Limited, Hulse & Company, Limited, W. H. Allen, Son & Company, Limited, Grafton & Company, and W. Simons & Company, Limited, and, in addition, is a director of the first-named concern.

MR. JAMES M. SWANK, who resigned his office of secretary and general manager of the American Iron and Steel Association, the work of which has been taken over by the American Iron and Steel Institute, has been the recipient, in the form of a testimonial, of resolutions passed by the directors of the American Iron and Steel Institute recording their profound appreciation of the fidelity and skill with which Mr. Swank discharged the duties of his office, and also their high estimate of his character as a man.

Deaths.

THE death is reported of Mr. James Macdonald, of the firm of Macdonald Brothers, engineers, Portsoy.

THE death has occurred at Southport of Mr. Walter Martin Musgrave, of the firm of John Musgrave & Sons, Limited, Globe Ironworks, Bolton.

MR. H. E. RANSOME, of Ransome, Sims & Jefferies, Limited, engineers and boiler makers, Orwell Works, Ipswich, has died at the age of 44 years.

MR. F. FOSTER, at one time a partner in the business of Foster Brothers & Company, Hope Foundry, Lancaster Road, Preston, has died at the age of 84 years.

THE death is reported of Mr. A. B. Frost, chairman of Pickersgill & Frost, Limited, ironfounders, Star Foundry, Langley Mill, Derbyshire, at the age of 48 years.

THE death is reported of Mr. H. A. Tristram, of the Andrews-Hawksley Patent Tread and Engineering Company, Columbia Works, Preston Road, Poplar, London.

MR. W. T. KNAGGS, for 14 years secretary of Sir B. Samuelson & Company, Limited, Newport Ironworks, Middlesbrough, who retired at the close of last year, died at Eastbourne on March 10, at the age of 62 years.

MR. J. Whyte, late engineer and iron founder, Dundee, died in London on March 2, aged 60 years. The deceased first began business in Perth, and a few years later founded the firm of J. & H. Whyte & Cooper, in Dundee. Subsequently he purchased the Tay Foundry, Maryfield, assuming as a partner, Mr. W. Bruice Mair.

MR. William Flint, died at his residence, 52, Brocco Bank, Sheffield, on March 1. He had been in failing health for two or three years, but resolutely followed his business. Deceased, who was 67 years of age, was a native of Pleasley Ville, near Mansfield and went to Sheffield about 45 years ago. For some time he was with Messrs. Samuel Osborne and Company. He afterwards embarked in business on his own account, in conjunction with a partner, taking over the firm of Messrs. Hydes and Wigfull. When it was made a limited liability company, he became a director.

MR. G. W. MAYNARD, a prominent American engineer, has died in Boston at the age of 74 years. The deceased gentleman acted as consulting engineer for iron and steel works in Great Britain, and in that capacity made at Middlesbrough practical demonstrations in a large way of the Thomas-Gilchrist process of steelmaking. Mr. Maynard returned to New York in 1879 for the purpose of introducing the Thomas-Gilchrist process into the United States, and, with the exception of brief professional trips abroad, remained in that country engaged in active practice as a consulting engineer.

NEWS of the death of Mr. Francis John Maw, who retired from the secretaryship of Cammell, Laird & Company, Limited, about fifteen months ago, will be received with deep regret by a wide circle of friends and business associates in iron and steel circles. For practically the whole of his career, Mr. Maw has been associated with Messrs. Cammell, Laird & Company, his service having extended over a period of more than forty years, for the latter part of the time in the position of secretary. When he relinquished this appointment, in December, 1911, he was the recipient of several handsome gifts from his colleagues, who held him in the highest regard. He was 61 years of age.

THE

FIRST FOUNDRY TRADES EXHIBITION

AGRICULTURAL HALL, LONDON, N. JUNE 14-28, 1913.

ALL ENTERPRISING MAKERS OF THE FOLLOWING SPECIALITIES SHOULD BE WELL REPRESENTED.

Abrasive Wheels.
Air Compressors.
Aluminium.
Annealing.
Ash Crushing and Washing Machines.
Barrels (Tumbling).
Barrows.
Bellows.
Blowers and Fans.
Buffing and Polishing Machines.
Casting Cleaners.
Cement.
Chaplets and Studs.
Charcoal.
Charging Platforms.
Coal Dust.
Coke Breakers.
Core Boxes.
Core Compounds.
Core Gums.
Core-Making Machines.
Core Ovens.
Core Ropes.
Core Vents.
Cranes.
Crucibles.
Cupola Linings.
Cupolas.
Emery Grinders.
Emery Wheels.
Facings.
Firebricks.
Foundry Blacking.
Foundry Brushes.
Foundry Rattlers or Fettling Drums.
Foundry Sand.
Furnaces.
Grinding Machines and Tools.
Hoists.
Ladles.
Magnetic Separators.
Mould Driers.
Moulding Machines.
Pig Breakers.
Pig-Iron.
Plumbago.
Pneumatic Tools.
Polishing Sundries.
Pyrometers.
Recording Gauges.
Riddles and Sieves.
Sand Blast Apparatus.
Sand Driers.
Sand Grinding Mills.
Sand Mixers.
Sand Riddling, Separating and Sifting Machines.
Smiths' Hearths.
Steel Moulders' Composition.
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Welding Plant.
Non-Ferrous and other Metals, etc., etc., etc.

IMMEDIATE APPLICATION FOR REMAINING SPACE

SHOULD BE MADE TO

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RESEARCH LABORATORY, LIMITED.—Capital £1,000 in £1 shares Registered office: 20, Bucklersbury, E.C.

NEW ENGINE COMPANY, LIMITED.—Capital £15,000 in £1 shares. Registered office: Junction Works, Hyt... Road, Willesden.

B. A. Y. STRONG & COMPANY, LIMITED.—Capital £1,500 in £1 shares (700 Pref.), to carry on the business of boilermakers, etc.

JAS. MILNE COOPER & COMPANY, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of manufacturers of copper jointing rings.

COMMERCIAL AND ENGINEERING DEVELOPMENT COMPANY, LIMITED.—Capital £1,000 in 500 ordinary shares of £1 and 10,000 deferred shares of 1s.

SANG & RUSSELL, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of engineers, etc. Registered office: 10, Union Court, Old Broad Street, E.C.

BEART & BLACKALL, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of engineers. Registered office: 1, The Parade, Brighton Road, Coulsdon, Surrey.

S. G. TURNER & COMPANY (BRISTOL), LIMITED.—Capital £3,000 in £1 shares, to carry on the business of engineers. Registered office: 67, Victoria Street, Bristol.

TELECA COMPANY, LIMITED.—Capital £2,000 in 1,750 participating ordinary shares of £1 and 5,000 deferred ordinary shares of 1s., to carry on the business of engineers.

WILLIAM DOVE & SONS, LIMITED.—Capital £18,000 in £1 shares (6,000 preference), to carry on the business of ironfounders, etc. Registered office: 42, Parliament Street, York.

C. A. PARSONS & COMPANY, LIMITED.—Capital £450,000 in £100 shares, to carry on the business of engineers, etc. Registered office: Heaton Works, Heaton, Newcastle-on-Tyne.

N. H. E. COMPANY, LIMITED.—Capital £10,000 in £1 shares, to carry on the business of engineers. Registered office: Ravenscroft Works, Scrubbs Lane, Willesden Junction N.W.

ROBERTS BROTHERS & HOLLOWAY, LIMITED.—Capital £1,500 in £1 shares, to carry on the business of engineers. Registered office: 3, Nutter Place, North Parade, Bradford.

BRITISH CHAIN MANUFACTURING COMPANY (1913), LIMITED.—Capital £60,000 in £1 shares (34,000 preference). Registered office: County Chambers, Westgate Road, Newcastle-on-Tyne.

HAMMOND BROS. & CHAMPNESS, LIMITED.—Capital £100 in 1s. shares, to carry on the business of engineers. Registered office: Kent Engineering Works, Alfreton Street, Old Kent Road, S.E.

J. GARDNER & COMPANY, LIMITED.—Capital £10,000 in £1 shares (2,500 preference), to carry on the business of engineers, etc. Registered office:—Monument Iron Works, Jacob Street, Dockhead, S.E.

DENNIS BROS. (1913), LIMITED.—Capital £300,000 in £1 shares, to carry on the business of engineers, and to acquire the business of Dennis Bros., Limited. Registered office: Onslow Works, Guildford.

W. A. HUDSON, LIMITED.—Capital £55,000 in £1 shares, to carry on the business of ironmongers, iron, brass, and metal founders, and to adopt an agreement with W. A. Hudson. Registered office: 117, Curtain Road, E.C.

WILLIAM WOODHEAD & COMPANY, LIMITED.—Capital £2,000 in £1 shares (1,501 ordinary "A" and 499 ordinary "B"), to carry on the business of machine-tool makers, etc. Registered office: 85, Queen Victoria Street, London, E.C.

WILLIAM CALDWELL, LIMITED.—Capital £2,000 in 1950 preference shares of £1 and 1,000 ordinary shares of 1s. each, to acquire and carry on the business of engineers and ironfounders at Dunterlie, Barrhead. Registered office: 22, Renfield Street, Glasgow.

ISAACSON & BROWN, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of electrical and mechanical engineers, manufacturers, and workers of electricity, motive power and light, etc., and to adopt an agreement with A. W. Isaacson. Registered office: 43-44, Furnival Street, Holborn, E.C.

J. SHORES & COMPANY, LIMITED.—Capital £3,000 in £1 shares, to carry on the business of founders, engineers, etc., to acquire the business carried on at Owston Ferry, Lincs., as J. Shores & Company, and to adopt an agreement with F. P. Engert. Registered office: Trent Iron Works, Owston Ferry, near Doncaster.

RICHARDS ANTI-RUST (FOREIGN PATENTS), LIMITED.—Capital £250 in £1 shares, to acquire from the Richards Anti-rust the benefit of certain foreign patents in relation to the treatment of metals and alloys for the prevention of oxidation, and to adopt an agreement with F. R. G. Richards and the said company. Registered office: 97, Little Park Street, Coventry.

JOHN MUSGRAVE AND SONS (1913), LIMITED.—Capital £128,000 in £1 shares (80,000 original preferred ordinary and 48,000 deferred ordinary), to adopt agreements (1) between A. Kirkham of the one part and J. P. Haslam, W. H. Hoyle, T. Magee, and T. Scowcroft of the other part, for the acquisition of the business of ironmasters, engineers, and boiler-makers, formerly carried on by John Musgrave and Sons, Limited, at Bolton and Westhoughton, Lancs. together with certain of the property and assets, and (2) with J. P. Haslam, W. H. Hoyle, T. Magee, and T. Scowcroft.

Limited Partnership.

ERNEST WAGNER & COMPANY.—Registered February 25. Tin refiners, preparers of tin and tin compounds from tin scrap, 48, Croft Street, Deptford, London, S.E. General partner: E. Wagner, 129, East Dulwich Grove, London, S.E. Limited partner: A. Maude, 6, Kimbolton Road, Bedford, contributing £300 in cash.

A REVOLUTION IN THE FOUNDRY.

THERE IS NOTHING LIKE IT.

Proved by the leading firms to be absolutely reliable and holds an impregnable position in the foundry after all others have failed

"SPERMOLIN" (Regd).

Is used by all the leading firms in the making of Cores of Castings for Steam Engines, Turbines, Gas and Oil Engines, Motor Car Cylinders, Pumps of all descriptions, Machine Tools, Radiators, Sectional Boilers, Gas Stoves and Gas Rings, Malleable Iron Castings, Steel, Iron and Aluminium Castings.

FOR FURTHER PARTICULARS WRITE TO:—

The SPERMOLIN Core Co., George Square, HALIFAX.

Or to:— **HALL AND GILLAM, EXCHANGE BUILDINGS, BIRMINGHAM.**

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

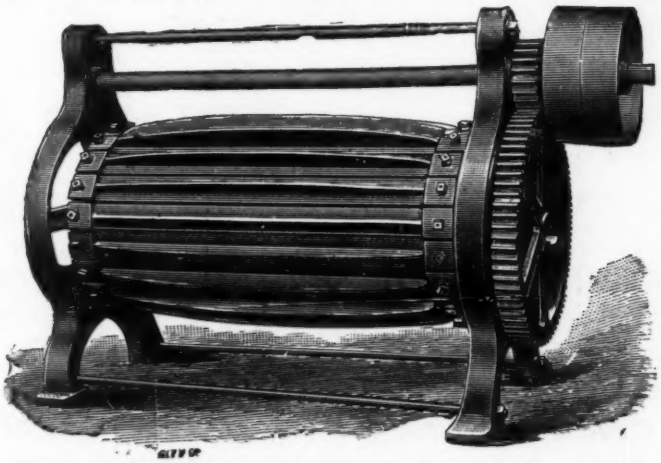
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

METALS.	End Mar., 1913.	End Mar., 1912.
Iron—Scotch pig warrants ton	*72/10½	*57/10½
—Middlesbro' warrants ton	66 10	51 11
—W.C. Mnos Bessemer ... ton	85 6	67 6
—Stock, Middlesbrough .. tons	215,813	1,000
Copper—Chili bars GMB ton	£65 10 0	£70 12 6
—Stock, Europe and afloat tons	45,674	63,007
Tin—English ingots ... ton	£220 0 0	£203 10 0
—Straits ... ... ton	£214 15 0	£196 10 0
—Stock, London, Holland, U.S.A., and afloat ...tons	12,117	16,615
Lead—English pig ... ton	£16 15 0	£16 10 0
Spelter—Ord. Silesian ... ton	£24 12 6	£26 0 0
Quicksilver (75lb)... bottle	£7 10 0	£8 12 6
Antimony—Regulus ton	£31 0 0 £33 0 0	£27 0 0 £27 10 0
Aluminium—Ingot ... ton	£88 0 0 £90 0 0	... —

*Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.		£ s. d.
Columns (p'lain)	7 7 6	to	7 12 6
Pipes, 1¼ to 2½ in.	6 12 6	to	7 0 0
,, 3 to 4 in.	6 5 0	to	6 7 6
,, 5 to 8 in.	6 0 0	to	6 2 6
,, 10 to 16 in.	6 2 6	to	—
,, 18 to 24 in.	6 2 6	to	—
Chairs	4 14 0	to	4 15 0
Floor plates (open sand)	3 10 0	to	3 12 6

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows: Heavy wrought (mixed), £2 17s. 6d.; light wrought, £1 5s. 0d.; heavy cast, £3 3s. 6d.; all per ton, f.o.b., London. Copper (clean), £63 0s. 0d.; brass (clean), £43 10s. 0d.; lead (usual draft), £15 0s. 0d.; Zinc, £18 15s. 0d.; all per ton delivered merchant's yards.

Legal.

Action on Bill of Exchange.

Judgment has now been delivered in the case in which the regularity of a bill of exchange was the question raised. The case was Matt. T. Shaw & Company, Limited, *v.* Holland & Neal, and was considered in the Court of Appeal before Lords Justices Vaughan Williams, Farwell, and Kennedy. The plaintiffs said the defendants were endorsers of a bill of exchange for £400, drawn by the plaintiffs and accepted by Lindsay, Neal & Company, Limited, and which was dishonoured. The plaintiffs had supplied goods to Lindsay, Neal & Company, Limited, for some time upon cash terms, but they agreed instead of the transactions being continued on a cash basis to draw bills upon the company at three months provided that the bills, in addition to being signed by the company, were endorsed by Messrs. Holland and Neal, two of the directors, who between them held the whole of the share capital of the company. Ultimately, a bill for £400 was dishonoured, and this action was brought. Defendants pleaded that the bill was irregular in that the plaintiffs upon getting the bill back had put their name after, instead of before, the names of the defendants, thus, it was said, relieving the latter from the position of endorsers and from primary responsibility to the drawers. Mr. Justice Hamilton, who tried the action, entered judgment for the defendants, but without costs; hence the appeal of the plaintiffs.

Lord Justice Vaughan Williams, in giving judgment, said he had come to the conclusion that the decision of Mr. Justice Hamilton was right. Lords Justices Farwell and Kennedy concurred, and the appeal was dismissed, with costs. It was intimated that the case might be carried to the House of Lords.

BLOFIL
THE
IRON CEMENT
(Quick or slow setting grades)
IS
THE CHEAPEST
AND
MOST RELIABLE
for all purposes.
Unaffected by oil, steam, or water.

Sole manufacturers—

RUDD & OWEN (DEPT. I)
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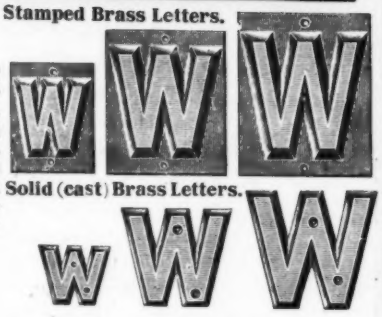
GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

WHITE METAL LETTERS

Stamped Brass Letters.

All kinds of Letters for Pattern-making and Foundries supplied from stock at very advantageous prices.



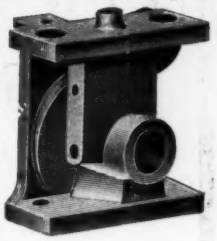
Solid (cast) Brass Letters.

Walton & Co.,

Newton Street,

Birmingham.

YOU CAN CUT DOWN COSTS ON COMPLICATED SMALL PARTS



¶ To obtain such a part as that illustrated above by ordinary methods of casting would entail an amount of time and money out of all proportion to the profit you should make on it.

¶ Why not secure the extra profit and the certainty of scientific precision that is offered you by using - - -

"Prana" Die-Finished Castings?

Holes, Slots, Teeth, Notches, Screw Threads, etc., are accurately cast — no machining. Send for Booklet F., mentioning this paper, to

AERATORS LIMITED

EDMONTON, LONDON, N.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

The "Tottenham" Portable Hot-Air Core Oven.

The Oven is built on a Scientific principle which causes a rapid circulation of hot dry air to pass round the cores. They are dried thoroughly right through; those on the top shelf being dried as quickly as those below. Burning the cores is impossible, as no flame or smoke comes into contact with them.

It is arranged for fuel or gas and is exceedingly economical in the consumption of either.

Call and see it.

THE "BUESS" OIL-FIRED CRUCIBLE MELTING FURNACE IS WITHOUT A RIVAL. THERE IS NO OTHER TO COMPARE WITH IT FOR ECONOMICAL WORKING AND SIMPLICITY OF OPERATION.

With our 15 different Types of Moulding Machines we cover the requirements of any foundry. Call and see them at work.

EMERY GRINDERS. ABRASIVE WHEELS.

THE LONDON EMERY WORKS Co., PARK WORKS,

TOTTENHAM, LONDON, N,

Passenger Station, Park G.E. Rly. **Telephone: Tottenham, 188.**

THE BUYER'S GUIDE

Addresses and further information will be found by reference to the Firm's Advertisement.

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Evans, J. & Co.
London Emery Works.
Jackman, J. W., & Co

Air Compressors.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Electrically Driven).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors(Steam).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Belt).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Aluminium.
British Aluminium Co., Ltd.

Annealing.
Evans, J., & Co.
Phillips, J. W. & C. J.

Ash Crushing and Washing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Barrels (Tumbling).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Hall, Charles, & Co.
Hooker, Peter, Ltd
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Standard Sand-Blast Machine Co., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

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F. Braby & Co, Ltd
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.

Bellows.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Durrans, Jas., & Sons.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Blacklead.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Blowers.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davis, T., & Son.
Dempster, R. & J., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Keith, J., & Blackman Co.,Ltd.
London Emery Work Co.

Blowers—*cont.*
Marseall, H P., & Co., Ltd.
Phillips, J. W. & C. J.
Samuelson & Co., Ltd
Thwaites Bros., Ltd.

Buffing and Polishing Machines.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Casting Cleaners.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Castings.
Aerators, Ltd.

Cement.
Dyson, J. & J.
Evans, J., & Co.
Hall, Charles, & Co.
Hawkins & Co., W T.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Lowood. J. Grayson, & Co., Ld.
Marshall & Co., Horace P.
Metalline Cement Co.
Olsen, Wm.
Plasti-Kion Co.
Rudd & Owen.
Silent Machine and Eng. Co.

Chaplets and Studs.
Durrans, J., & Sons.
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Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Motherwell, Wm., & Co.
Olsen, Wm.
Wilkinson, T., & Co., Ltd.

Charcoal.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Mansergh, T. E.
Walker, I. & I.

Charging Platforms.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Thwaites Bros., Ltd.

Coal Dust.
Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Mansergh, T. E.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Coke (Foundry).
Elders Navigation Collieries.

Coke Breakers.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Core Boxes.
Evans, J., & Co.
Jackman J. W., & Co., Ltd.
Olsen, Wm.

Core Compounds.
Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson Thos., & Co.

Core Gums.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Core Making Machines.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.

Core Ovens.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Hislop, R. & G.
Jackman, J. W. & Co., Ltd.
Jones & Attwood, Ltd.
London Emery Works Co.
Phillips, J. W. & C. J.

Core Ropes.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, T., & Co.

Core Vents.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Cranes.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Ward, T. W., Ltd.

Crucibles.
Evans, J., & Co.
Hall, Charles, & Co.
Olsen, Wm.

Crucible Furnaces.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Lt .

Crucible Furnaces (Lift-out).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

Crucible Furnaces (Tilting).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Crushing Mills.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Cupolas.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Derby Boiler Co., Ltd
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W , & Co., Ltd.
London Emery Works Co.
Marshall, H. P. & Co.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Cupola Linings.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Emery Grinders.
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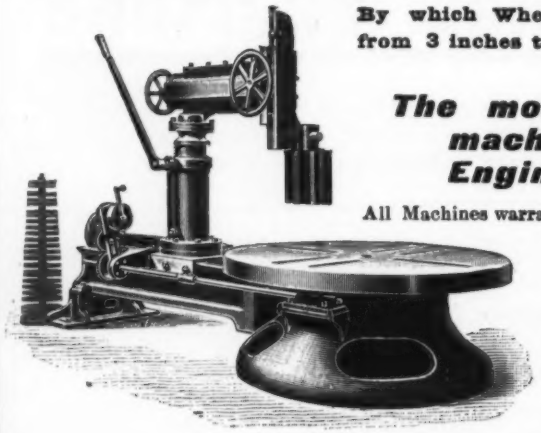

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268 & 309	Evans, J., & Co.	Manchester	Ladles, Manchester	2297
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	Herbert, Alfred, Ltd...	Coventry	Lathe, Coventry	526 Coventry
262	Hislop, R. & G.	Paisley	Gas, Paisley	331 Paisley
C. iv.	Jackman, J. W., & Co.	Caxton House, S.W.	Molders, London	30 Victoria
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	Silent Machine Co.	Albion Works, Savile St., Sheffield	Forward, Sheffield	—
314	Spermolin Core Co.	Georges Square, Halifax	Spermolin Halifax	—
257	Standard Sand Co., Ltd.	Mansfield	Standard Sand Co., Mansfield	201 Mansfield
263	Stewart, D., & Co. Ltd.	London Road Iron Works, Glasgow	Stewart, Glasgow	71 P.O. Bridgton & 3243 Bridgton (N)
C. iii.	Tilghman's Patent Sand Blast Co., Ltd.	Broadheath, nr. Manchester	Tilghmans, Altrincham	14
267	Thwaites Bros., Ltd.	Bradford	Thwaites, Bradford	345 9&3460 Br'df'rd
263	Walker, I. & I.	Rotherham	—	—
315	Walton & Co.	53, Newton Street, Birmingham.	"Walco," Birmingham	Central 3305
320	Whittaker, W., & Sons, Ltd.	Oldham	Whittakers Engineers, Oldham	83
260	Wilkinson, Thos., & Co., Ltd.	Middlesbrough	Blacking, Middlesbro'	419

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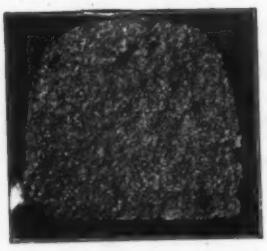
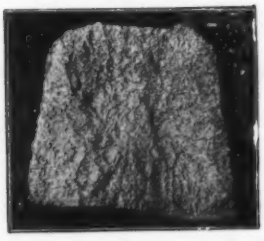
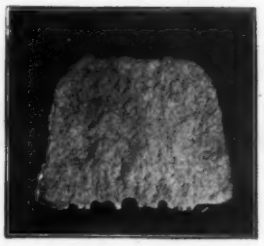

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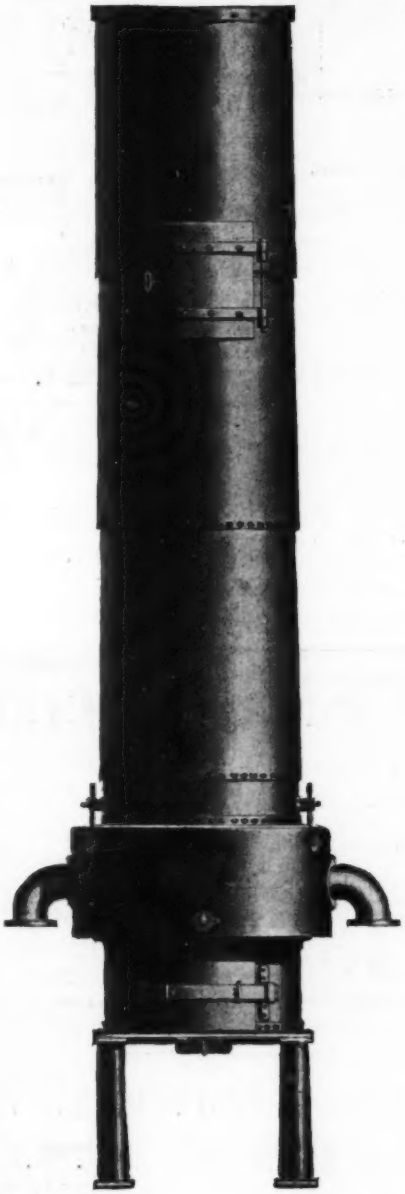

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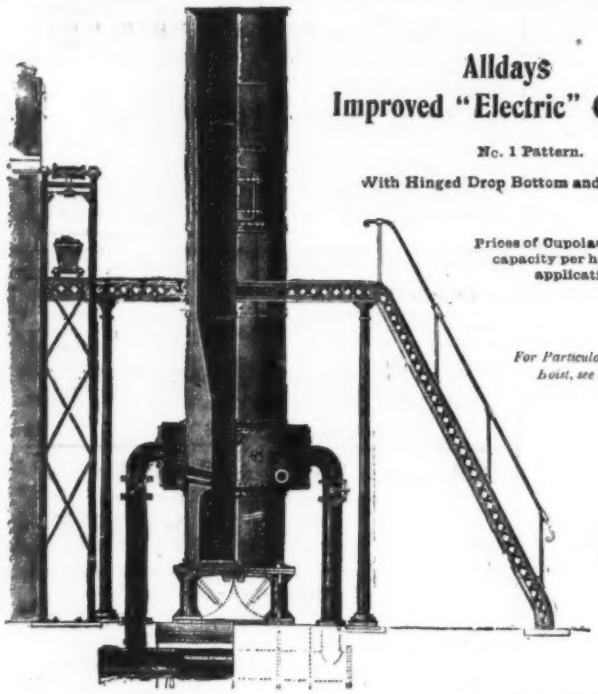

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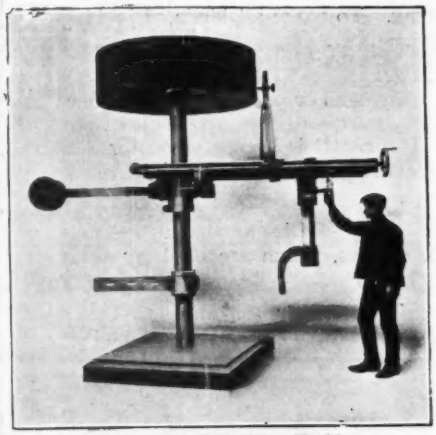

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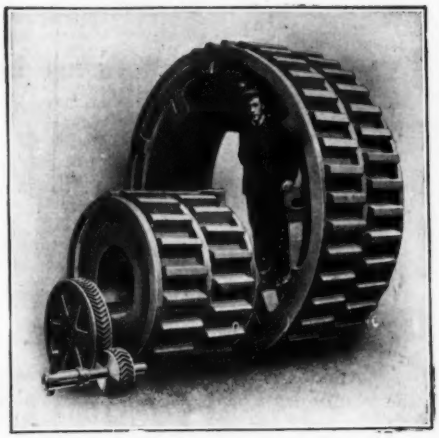

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McLAIN'S SYSTEM is complete information and instruction on Mixing Irons by Analysis, Scientific Melting and Good Cupola Practice and the Making of Semi-Steel.

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YOU CAN TAKE ANY CUPOLA, HOME-MADE OR OTHERWISE and arrange it to melt iron scientifically, which means using the least amount of coke, 12 to 15 lbs. of iron to 1 of coke between charges, melting up to cupola capacity and producing the best metal.

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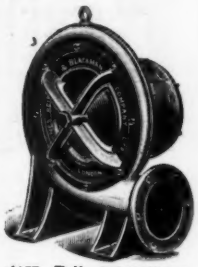
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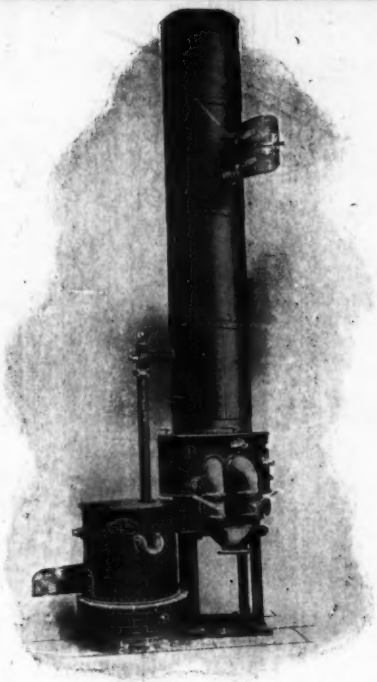

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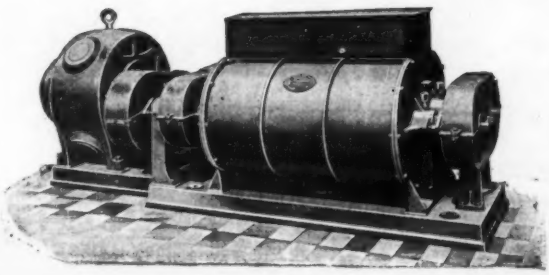

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